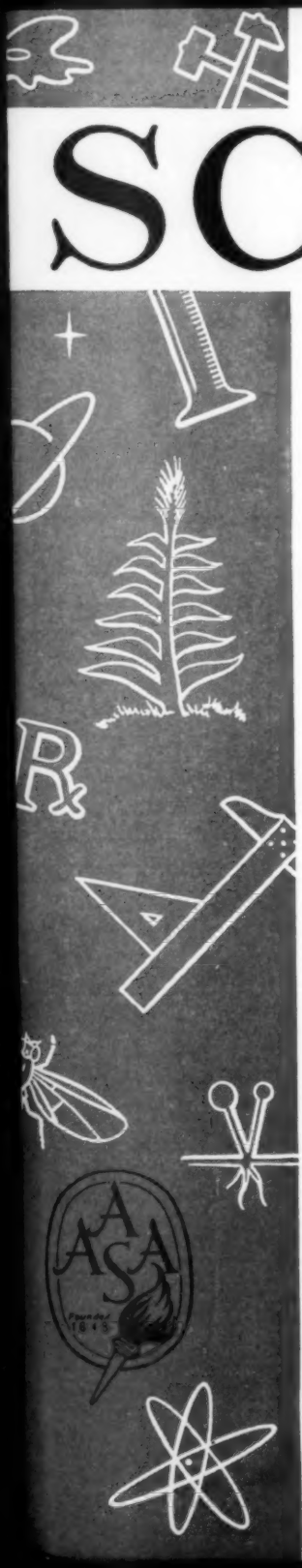

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APRIL 18, 1952

VOLUME 115 NUMBER 2990

Annual Book Issue

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*	8658	pyrom. check (lab. & plant); temp.					x	single; direct-reading temp.
Temperature *	8659	pyrom. check (lab. & plant); temp.					x	double; direct-reading temp.
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Scientific Books

Most original scientific research today is reported in the scientific journals. These journals, numerous as they are, are flooded with papers, and journal editors often require authors to save space by paring their reports to the barest essentials. Caught between the surge of postwar scientific research and alarming increases in the cost of technical printing, the journals, carrying the lifeblood of current research, have their problems, editorial or financial, or both.

If journals are the chief vehicles of current research, what is the importance of books? The very existence of this special book issue of the news organ of the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE is ample testimony to their importance. But what is the relation of books to scientific progress?

The answer to this question is immediately seen by imagining a world without scientific books—no popularization of science, no textbooks, no advanced treatises, no reference books. Skillful and accurate popularizations are necessary to keep the public informed about the state of science, an increasingly important function in an era when so much research depends on public support. Popularizations often spark the interest of the younger students who will be tomorrow's scientists. Textbooks, too, are necessary. Imagine trying to teach a course in beginning biology without a textbook; in order to teach the course the teacher would have to write one. Reference books and advanced treatises, at a professional level, also fulfill their function. Only in the broad perspective that a book affords is it possible to stand back and view an area of science as an entity. Only in books is the unity of science fully revealed.

But while extolling the virtues of books, we must not think that books constitute the tangible body of science. Science is what scientists think and do; books, like cyclotrons, are merely their tools. In building a cyclotron, one may find a new fact about particles in motion; in the organization and reflection that goes into writing a book, one may discern new facts and relations not previously discovered. And when a book is written and published, it becomes a tool. It may be valued for the facts it contains, for the interpretations it presents, for the clarity of its exposition for beginners, or for the vitality and enthusiasm with which it presents the results of science to the public.

The reviews in this issue show that, although some scientists have vowed never to stray from the frontier of current research in the journals, others have suffered the birth pangs of book publication—for the benefit of science. The publishers, too, those toolmakers, have suffered pangs—especially growing pains. Since 1940 a large part of the mantle of responsibility for scientific publication, formerly carried magnificently by Germany, has fallen on American publishers. This, with the tremendous burst of American scientific activity, plus the ever-increasing cost of book production, has created new problems and has intensified old ones for American publishers. Fortunately, in this case, virtue turns out to be its own reward. Publishers who have held to a high level of quality in selecting their publications have been able to meet the challenge. The following pages show that in America good scientific books are being published in large numbers; and, like reservoirs, they store the growing volume of scientific knowledge until it is tapped for the further advancement of science.

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SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948.

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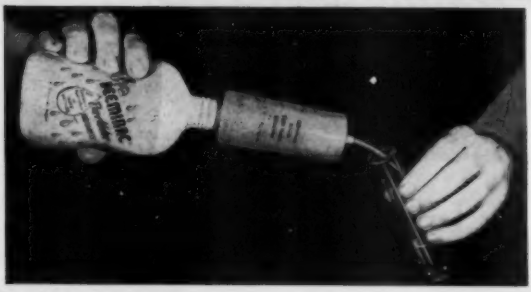

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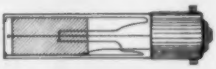

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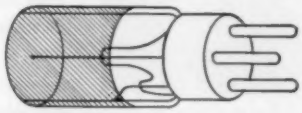

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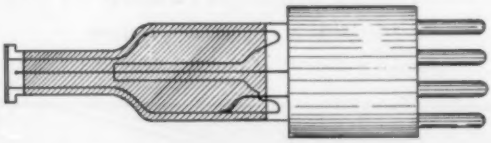

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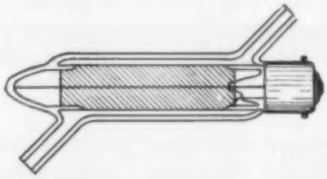

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The Criticism of Scientific Books

Marston Bates

Rockefeller Foundation, New York

THERE WERE 11,255 books published in America in 1951, according to the statistics of *Publishers' Weekly*. Of these, 722 were classed as "science"—a small number compared with "fiction" (2135) or "juvenile" (1072), but larger than any of the other categories except "religion" (731). "Medicine and hygiene" are included in a separate listing, with 478 titles, as are "sociology and economics," with 506 titles.

Two books on science every day make a respectable enough showing, yet few of us feel that science is being adequately explained to the general public, or that the problems of science and society are receiving adequate attention from our intellectual leaders. To be sure, many of the 722 titles are textbooks designed for special purposes, and many others are technical volumes aimed at narrow reader groups; but there must still remain a considerable annual flow aimed at informing the general reader about this or that aspect of science. I doubt whether many of us feel that there should be more books on science; but probably all of us feel that the books that are published should be given more attention, and that more of them should be written in a fashion that would warrant wide attention.

The improvement of this situation depends on us, the scientists of America. Professional journalists may have responsibility for the final steps of popularization, in news stories for the daily press and in articles for magazines of mass circulation. Writing for such media requires training in the special techniques of arousing and maintaining interest, and takes more time than a working scientist would have available. But even in this case the background material must come from the scientists, by way of the books and articles that summarize our growing and changing knowledge. Only a specialist can find his way through the maze of current technical reports to emerge with significant facts and trends; and only the working scientist can get the "feel of the material."

Scientists themselves can and ought to write in a way capable of reaching a wide and influential audience. There is a long history of distinguished scientific writing to prove this—perhaps more obviously in England than in America. It is understandable that a painter or musician might not be able to explain his works in words, since he is dealing primarily with a different kind of symbolism. But every scientist must deal with words, except to the extent that he can substitute mathematical formulations, and every scientist must, then, for his own purposes, master the techniques of writing. The basic principles, of clearness and simplicity, ought to apply as much to research reports as to popular books. The differences are relative, depending on the amount of knowledge presupposed in the reader, which in turn controls the extent to which technical short-cuts in vocabulary can be used.

Why, then, do we not produce more scientific books that are readable? Partly, I think, because we are afraid of one another. Scientists can be very mean to one another, and fear of criticism is one of the things that keeps us all in the straight and narrow path, even in our research work. This is healthy. The standards of scientific work seem to deteriorate easily when criticism is absent, or when it is directed by nonscientific outsiders, as in totalitarian regimes. But we need to be careful that our criticism is constructive, and that it is adjusted to the nature of the material under scrutiny.

I admitted once that in my own writing I was always conscious of ghostly colleagues peering over my shoulders, looking for the mistakes. As a result of that confession, many scientists have told me that they feel the same way, and that, in writing, they are impelled to throw in technicalities and qualifications that slow up the pace and do not really modify the conception, merely as sops to these ghostly critics. I have been surprised to learn that this applies even to people whose accomplishments and prestige would seem to allow them to rise above such considerations.

This attitude toward the popularization of science is intangible, difficult to define and even more difficult to modify. On the one hand, we are all anxious that science be more generally understood and appreciated; but, on the other hand, we are unwilling to give the breaks to people who attempt to further this objective. It is true that in America the best-selling books on "science" have often been dismal affairs, and their authors have perhaps deserved the opprobrium they have gained from the scientific community. The effect, however, is to reinforce the feeling that the opprobrium is attached to the popular success rather than to the bad science.

One remedy for this situation might be the development of a special field of criticism for attempts at scientific popularization. As it is now, all books on science get about the same treatment, regardless of the audience at which the book is directed. The reviewer will note the inadequate index and faulty documentation, correct three misprints, reprove the author for not citing work published six months before (forgetting the time lag between manscript and publication, and the cost of changes in proof), and gleefully point out all the howlers he can find. The reviewer may also point out that the book has adequately summarized knowledge in the particular field covered, and note that current ideas have been effec-

tively presented; but these positive values are lost in the catalogue of faults. We rarely try to evaluate the book in terms of how well it has succeeded in attaining its objectives; we are ready to damn, but we are cautious with our praise. (This is no personal peeve, because my reviewing colleagues have been kind—even suppressing mention of howlers in their reviews and pointing them out by letter instead.)

A scientist thrives on the good opinion of his colleagues. If, then, we really want scientists to write readable books that will reach nonscientific readers, we must recognize accomplishment in this just as we would recognize accomplishment in research. The best way, I think, is by giving serious attention to such efforts in our scientific journals.

Such attention might also help with the other problem—that of giving the good books wider circulation. A given book is likely to get lost in that annual flood of 700 volumes; and it is also likely to get lost in an even flow of equally numerous, equivalently written, book reviews. The reviewing should serve a selective function, not only sorting the books into their different categories, but also giving some indication of their relative potential importance.

At first sight there would seem to be little connection between the notice of books in scientific journals and their circulation among nonscientific readers. Probably there is, in fact, no connection at the present time. But if we developed a really live scientific criticism, this might serve the literary critics by drawing to their attention the books that we think most seriously warrant that attention. Also, each scientist is a point of contact with many parts of the nonscientific world. Whether in a university or in industry or government, each of us has many opportunities to recommend reading about science to nonscientists, and we ought to be in a position to make intelligent recommendations. All of us have a hard time keeping up with the research literature in our specialty, and we cannot possibly undertake the additional task of independently judging the general literature of science. We need guidance to the books that we ourselves should read about fields of science in which we are not directly working, and to the books that we might want to recommend to our friends.

The development of a lively criticism of scientific books would mean a considerable editorial burden, since the editor must screen the books that pass over his desk, judge space requirements, find capable reviewers, persuade them to deliver the goods, sometimes edit the product, and try to be alert about unfair judgments. I think SCIENCE should take the lead in this effort. It is the weekly source of news about science for the majority of American scientists, and surely general books about science are an important item of scientific news. The technical books can safely be left to the specialized journals, or be given a short notice for prompt announcement of publication.

As it is now, the best reviewing of general scientific books occurs in the monthly or quarterly journals. The *Quarterly Review of Biology*, for instance, has a long history of distinguished book reviewing. But reviews in such journals reach a restricted audience, and their publication is often greatly delayed. They serve an important scholarly function because of the complete coverage, and because the evaluations have been made in a leisurely way by competent authorities. These reviews can serve to deter the popularizer, because he knows that eventually his colleagues will expose his sins in their learned pages; but no matter how sympathetically written, they can have little effect in encouraging popularization, because of their limited circulation.

The development of a constructive criticism on general scientific books might seem to be a function of the general magazines of science, such as THE SCIENTIFIC MONTHLY, the *American Scientist*, and the *Scientific American*. Certainly these journals now play important roles. But, after all, the development of vigorous criticism will require the expression of a diversity of opinions in different publication media. People who take much interest in general literature follow the reviews in both the weekly and the monthly periodicals, and I have never heard anyone (certainly not authors!) complain of the duplication.

We need, of course, to have more and better coverage of scientific popularizations in the literary periodicals, because these periodicals are read by the general public at which we are aiming. I think, however, we must go lightly on the editors of these journals, because that whole annual flood of 11,000 volumes passes over their desks, and it is no wonder that many interesting items in the science section get overlooked or mishandled. It seems to me that we, as scientists, ought to take the lead in our own journals. If we set the pace in selection and appraisal, and the literary journals pay no heed, we can start throwing stones.

Actually, the literary reviews often do surprisingly good jobs with scientific books. The *Saturday Review of Literature* especially, I think, deserves praise for the space and attention that it devotes to science. Science writing, to get attention in these reviews, must be good writing and interesting writing; and that, again, is our problem.

Who should write our book reviews? Editors of both scientific and literary journals have a tendency to send a new book to the man who has most recently written a book on the same general subject. This has an advantage, since the reviewer should know the subject; but it also has disadvantages. Sometimes, both in literature and in science, it leads to mutual back-scratching, which may be very pleasant for both parties but of no help to the onlooker; and sometimes it leads to consequences that are not pleasant for anyone. I do not believe that book writing and book reviewing are necessarily related abilities; and it is hard for one author to look with real impartiality on the books of another author. (I keep resolving not to write any more book reviews myself, but then the temptations of this easy road to a free library overcome my scruples. Editors ought to withhold temptation from such weak characters.)

It must be a hard job for an editor to build up a reliable corps of reviewers. I wonder whether the best reviewing might not be done by relatively young men, whose eyes are not yet clouded by the accumulated prejudices of their working careers. Ferreting out such talent would not be easy for an editor, and this is something in which we might all help by keeping alert to the potentialities of our younger colleagues and forwarding suggestions to our journal editors.

In writing about the criticism of scientific books, I have tackled only one small angle of the large problem of the explanation and interpretation of science, but I think it is a key angle: both because it should influence and enhance the prestige value of successful popularization among scientists themselves, and because it seems a basic mechanism for sorting out the good from the bad in the annual flood of books.

Actually, I think the outlook for an increasing understanding of science by the American public is very good. During 1950, with *Worlds in Collision* and *Dianetics* keeping their steady place on the best-seller lists, the outlook was gloomy indeed. But, for many months now, a glance at the weekly papers has always been reassuring. There, at the top of the list, *The Sea Around Us* kept its place. I do not believe scientists had anything to do with the establishment of Miss Carson's book,[1] but her accomplishment proves that there is a wide audience capable of appreciating a serious interpretation of a field of science. We cannot, then, blame the public for failing to notice our writings; we must look to ourselves and see how we can manage a better and more persuasive job within the limits of our canons of taste and integrity.

[1] As an editorial note, it might be mentioned that Chapter 7 in Rachel L. Carson's book was published in *The Yale Review*, where its merit was recognized by scientists. It received the AAAS–George Westinghouse Science Writing Award for magazines at the Cleveland meeting of the Association in 1950, several weeks before *The Sea Around Us* was published.

Reporting Science

Frank Carey

Science Reporter, Associated Press, Washington, D. C.

EVERY ONCE IN A WHILE I get a letter from some young man with ambitions to become a science writer for a newspaper, asking me how to go about it. My first advice is: "Go get yourself a job on a small newspaper and go out and cover a fire." If this sounds like heresy to a scientist, so be it. But, actually, it is not only sound advice for the prospective science writer, but possibly an indirect contribution to the advancement of science itself. The point is that if anyone expects to write science for laymen he must be first and foremost a good all-around reporter of news.

The obvious way of getting reportorial training is to do all the things that work on a small-town newspaper requires. It can mean chasing the fire engines to a big blaze, riding with the cops to the scene of an accident or to a raid on a bookie joint, buttonholing the mayor or the city councilors at City Hall, or interviewing labor leaders on a picket line on a rainy day. It can also mean covering a concert, a ball game, a clambake, a strawberry festival, or the "carrots-peas-and-chicken-a-la-king circuit" of service club luncheons.

And why is all this grist for the mill of the would-be science writer when, of itself, it isn't even remotely connected with science? First of all, if he has the makings of a reporter, it teaches him what constitutes *news* and also how to get facts straight—often under conditions of rush and other stress. (And if you don't think a science reporter is called upon to work under such conditions at times, watch one trying to interview a gun-shy scientist who, after making a controversial statement at a scientific meeting, insists he has only ten minutes to make a train. Or watch a science reporter break for a telephone after a news conference of the Atomic Energy Commission has produced the makings of a page one story.)

Second, it teaches him that the particular story he's covering on a certain day must compete, for inclusion in the paper, with stories coming in to the newspaper from all over the city, the state, the nation, and the world. Thus, he may learn to marshal his facts and to lay down his story in such an interesting way that even on a day when hot news is breaking everywhere, he'll still make the paper with his yarn. Also, he should learn that, even though his story may wind up on the city editor's desk spike, tomorrow is another day—and he'll keep pitching. As a science reporter, he'd face that situation constantly, particularly if he became a science reporter for a wire service like the Associated Press. Stories totaling more than 100,000 words a day move on the wires of the AP to newspapers all over the world—and news interest is the prime criterion in the selection of stories that make the wire. The wire is not made of rubber.

If the science reporter comes up with a story about a new and effective treatment for the common cold, he's in the money so far as getting it on the press association wire and into an individual paper is concerned. The same may be true, even on a hot news day, of a science story that reports NO new treat-

ments, NO new cures, yet has elements of human appeal that allow it to stack up against fast-breaking news.

An AP story on the discovery of "hooked-tailed mice" was published in a lot of newspapers recently, even though it was written on a day when political, international, and other news was running a high temperature. And it wasn't just a gag story about an oddity of nature; it was intended to illustrate, in an eye-catching way, some of the unusual aspects of research on heredity.

Sometimes scientists are inclined to shudder at the "hooked-tailed mice" type of story, or at least some of them say they do. They don't object to the scientific content, but to the approach a reporter makes to such a story. They maintain reporters go out of their way to emphasize the bizarre. Yet they forget that, if it weren't for the publication of this type of human-interest story, a lot of people might forget that scientists are working on many fronts to solve still-unanswered questions about heredity and many other things. And scientists, whether they admit it or not, need the interest of the people, because the people, directly or indirectly, foot the bills for much of research.

All right. Let's say the prospective science writer has become somewhat of a hot-shot as an all-around newsman. Does that equip him to write science day in and day out as a regular thing? Far from it. Like any other specialist in the news field—be it labor, politics, diplomacy, or military affairs—the science man must train himself in ALL the fields of activity about which he'll be called upon to write. These fields extend literally from A to Z—from atomic energy to zoology and from astronomy to the physical properties of zirconium. Most scientists have a rather thorough knowledge of their own particular field of activity, whether it be physics, chemistry, biology, or whatever—and a cursory knowledge of most of the other fields. A science reporter must have somewhat more than a cursory knowledge of ALL fields—a large order, true, but the science writer must build it up by his own reading, by interviews with scientists as he goes along, and, if he has the chance, by further formal education.

Some science writers happened to have specialized in science while in college, and that's all velvet. But some of the top men in the science-writing field today didn't have even that much background. *They* simply had to work all the harder to acquire their skill. A good, all-around reporter—including the man whose regular job is to cover the police station—can cover a science story adequately if he has the persistence to keep hammering away at questions on points that aren't clear to him. In fact, one of the early winners of the AAAS–George Westinghouse Science Writing Award for newspaper science reporting was a reporter who was not a specialist in science.

But the science man can oftentimes catch a story that other reporters would miss—a top story that might develop from a chance phrase at a news conference, or from two or three key words in a rough-reading technical article in a scientific journal. With his background, he can provide fast amplification when a science story breaks in the news.

The science reporter is sensitive to the strange lingo of science, and some of his best stories come from journals that are, perhaps, combed more thoroughly by science writers than by scientists themselves. In fact, some scientists will admit that the first knowledge they had of certain scientific developments came from reading about them in the newspapers.

Sometimes a science reporter does things that the scientific world, for one reason or another, has not tackled itself. Some months ago, this reporter set out on a project designed to explain the issues in the controversy between Sister Elizabeth Kenny and most of the medical profession regarding the nature and treatment of infantile paralysis. He read scientific books and journals totaling many pounds in weight, yet nowhere could he find any completely clear-cut exposition of the issues by either side of the controversy. So he had to write letters to doctors in various parts of the world and personally interview scores of doctors and technicians before he could nail down a reasonable explanation of what the scrap was all about. Regardless of which side is right in this controversy, it would seem that some impartial scientific group should long ago at least have outlined the issues to the public.

It was indicated earlier in this article that good science reporting could help science itself by explaining research projects to a public that ultimately pays many of the bills. Good science reporting can also help the public in a way that goes beyond education for education's sake. Thanks to accurate reporting of medical and public health news in newspapers and magazines during the past few decades, the general public should be fairly well informed on such matters—to the extent that it can ask intelligent questions in talking to doctors and have a good idea of the meaning of his replies.

When you call in a doctor, you imply your faith in him to handle the situation. But you're entitled to ask questions, and no fair-minded doctor should resent them, regardless of how busy he may be. Also, an intelligent understanding of the case by the patient or the patient's relatives should help the doctor in administering effective treatment.

Good science reporting can also alert the public to health hazards and to early symptoms of diseases such as cancer and diabetes. There are science writers who know of instances where a story they wrote about some recently developed drug was the means of calling it to the attention of a patient and his doctor in an out-of-the-way place. Many scientists and medical men cooperate with science reporters in the job of describing the things of science and medicine to the public. But there are still too many rhubarbs on the science beat.

Some scientists still have the impression that science writers think—and write—only in terms of the

melodramatic and the bizarre, generously sprinkled with inaccuracies. Rarely, however, can they cite specific instances. Most of their inhibitions are throwbacks to the bygone days when some newspapers kidded science and scientists, or sketched their doings with a lurid pen. Today, the average science reporter plays a science story for what it's worth. He doesn't strain to be cute or melodramatic, but if there is humor or drama inherent in the story, he plays that to the hilt, too. If his facts are straight—and he bends over backward to try to make them so—his one thought is to present them in the most readable fashion from the standpoint of a layman. He hopes the scientists will like his story, too, but he's writing primarily for people who do not necessarily have any background in the subject discussed.

Most of the men and women who report science for newspapers and magazines belong to the National Association of Science Writers (NASW), which was organized in 1934 for the express purpose of promoting accurate, responsible science reporting. The organization has grown from a virtual handful of charter members to close to 150 active and associate members today. The NASW is affiliated with the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE; but, to my knowledge, no member has ever allowed that affiliation to influence his writing toward the overtechnical side of the fence.

How does the science writer know what is interesting and readable to a layman? Well, if you'll pardon the obvious, he's a layman himself. Although he associates a lot with scientists and has close personal friends among them, most of his cronies are laymen—and he knows what interests them. Personally, I sometimes try some of my stories "for size" on the fellows around the office or on neighbors who come into my house—and if I detect a faraway look in their eyes, I junk the story.

So far as I know, no definitive public opinion poll has ever been taken to determine *exactly* what *all* readers want in the way of story content and presentation. But a newsman who has read all kinds of papers for years has a fairly good idea of the type of story that is used by most papers. And you can't get away from the conclusion that papers wouldn't be using them if their publishers were not sure that the stories were the kind liked by their readers.

The National Association of Science Writers recently helped conduct a poll of newspaper editors to determine their preferences among different kinds of science stories. Medicine and health stories ranked high. Scientific polls like that, conducted on still other questions in the science-writing field, should prove increasingly helpful. The science writers have every confidence that they have the right slant in presenting their stories, but, like the man in the laboratory, they are continually seeking specific evidence.

It has sometimes been stated by scientists that popular presentation of science should be done by the scientists themselves, *not* by laymen. In fact, when Kent Cooper, executive director of the Associated Press, decided years ago that everyday people were interested in science and that science could be handled just like any other news, a scientific friend suggested that Cooper get a scientist and train him to be a reporter. "No," said Cooper, "we'll do it the other way: we'll take a good reporter and train him, in effect, to be a scientist." Cooper was one of the pioneers in introducing straight reporting of science in newspapers and magazines, and the idea has paid off richly.

Although there are brilliant exceptions, most scientists simply cannot write the type of article that makes for good reading by the laity. It's not that they can't handle the English language; it's just that they are accustomed to talking most of the time in scientific jargon. Even some of the down-to-earth men I interview are occasionally inclined to throw in a few "one-to-the-minus-tenths" in the course of our conversation. Fortunately a science reporter can translate that in writing his piece, but it gives you an idea of the fast curves the scientists might throw in writing for popular consumption themselves.

Now and then I get a so-called abstract of a scientific paper from a scientist who tries to be helpful by writing it in what he thinks is good journalese. Invariably, it's not so hot, to put it mildly. Most of the writing done by scientists is for their own scientific journals, and I sometimes think that even within their own lodge they could make some improvements. I speak especially of the writing in journals of scientific organizations whose memberships include scientists in every field. You can't tell me that a physicist always knows what a chemist is talking about; or that a geologist is hep on all the phraseology of zoology.

The technique of the science reporter, who attempts to make his articles understandable to everyone of average intelligence, might well be adopted by the scientists in their own league. In fact, it might step up circulation.

Speaking of "abstracts" supplied by scientists to reporters—and I use the words "abstracts" and "supplied" advisedly—there's another big problem. In covering big scientific meetings, where several hundred different papers may be presented at scores of different sessions, it's obviously a physical impossibility for the best legman in the world to cover everything personally. He should be supplied *in advance of the meeting* with full texts, or at least fairly comprehensive digests, of what the scientists are to discuss. This enables him to pick the best news possibilities from among them. Sometimes he can work directly from the paper or abstract to get his story; often he may have to interview the scientist to get further explanation. But at least his battle plan can be outlined in advance.

Unfortunately, getting these papers or abstracts is often like pulling teeth. Moreover, some of the abstracts that do come in are frequently two-line affairs disclosing such "complete" information as this: "New studies of the action of certain pathogens *in vitro*

will be discussed. Interesting contrasts with previously described organisms will be reported. Period."

Maybe there's a good story there; maybe it's just a washout. But the reporter, with no means of knowing, must barge out and buttonhole the scientist—perhaps winding up with nothing, and meanwhile losing an hour or so of time. Reporters have deadlines to meet; they can't afford many wild goose chases.

Many scientists try to cooperate with the reporters. But some of them are fuss-budgets about minor things. Some of them have sincere fears about being made to appear to be publicity seekers merely because they talk to reporters. They forget that reporters may be just seeking additional information on something the scientist has already reported at a scientific meeting or in a technical journal. If their scientific colleagues condemn them for that, scientific organizations should do something about protecting their men from such criticism.

Some of the top medical and scientific organizations have issued policy statements urging their members to cooperate fully with responsible reporters. That's all to the good; but there ought to be more of it. We sometimes have to deal with really stuffy characters among the scientists and occasionally encounter one who is just plain rude and coarse.

All in all, however, the science-writing job is nice going, and it looks like an exciting future. Who knows? Perhaps we'll someday go on a press junket to the moon!

The Impact of Science on Literature

Fred A. Dudley

Department of English, State College of Washington, Pullman

TWO THOUSAND YEARS AGO the Roman poet Lucretius wrote *On the Nature of Things*, a great poem and a serious consideration of science. He was not the first literary man to reflect the thinking of students of nature. The impact of science on literature is almost as old as science itself and has grown more pervasive with the passing generations.

Except for the work of a few scholars the study of that impact is comparatively new, unorganized, and hampered by the literary scholar's lack of specialized knowledge about science. But it exists, and for twenty years or so it has been fairly active. Among its products are works that not only illuminate history for the student of literature, but might also command the attention of the thoughtful scientist.

Curry's masterly monograph on Chaucer (*1*), for example, clarifies a major author's total knowledge and use of the science of his time. Beach (*2*) and Lovejoy (*3*) trace the manifestations of seminal ideas partly rooted in science, Lovejoy dealing with pre-Darwinian views that now sound evolutionary, and Beach with the nineteenth-century concept of nature. Nicolson (*4*) makes vivid the intellectual and literary excitement created by the work of Newton. Stevenson (*5*) does something similar for the consternation that Darwin caused. Babb on Elizabethan psychology (*6*) and Johnson on Renaissance astronomy (*7*), each examining one science at one period and seeking out its reflections in literature, demonstrate how essential to the history of culture is some awareness of the course of scientific thought.

More limited explorations are numerous. How sound are Henry Adams' literary and philosophical applications of physics? What is the proper estimate of Goethe's passionate scientific misconceptions? How did the Royal Society's program for the clarification of scientific prose affect literary style? On such questions the journals of literary scholarship are stockpiling materials for a history of science in literature.

The outburst of eager praise that celebrated the achievements of Newton is almost unique in literary history. Copernicus and Galileo were dangerous heretics and made way slowly. Lyell and Darwin were shockingly irreverent. Einstein is fascinating but incomprehensible. Science has so often angered or bewildered literary men that at almost any time in history it is possible, and at most times easy, to find poets deploring or opposing current scientific thought.

One central force in this hostility, religious anti-scientism, long antedates the nineteenth century and is vigorously alive in the twentieth. Since the days when "science" meant about the same as "magic," pious obscurantism has found something evil in curiosity about the secrets of nature. The Faust legend is full of the idea of forbidden knowledge, of black magic, of secret and horrible commerce with Satan. In Elizabethan and Restoration drama scientific ideas abound; but the "virtuoso" himself, whether awesome sorcerer or contemptible quack, is often a damned soul. Milton's cosmological ambiguities reflect at least some hesitation on theological grounds. Geological impiety shocked the gentle Cowper:

> Some drill and bore
> The solid earth, and from the strata there
> Extract a register, by which we learn
> That he who made it, and reveal'd its date
> To Moses, was mistaken in its age.

Tennyson rebelled against theories he could not reject. Grieving to have lost a clear intellectual sanction to

faith, he saved it by setting emotion above reason. Wisdom, or faith, must rank higher than knowledge, or science, which was admirable but not preeminent:

> Let her know her place;
> She is the second, not the first.

Human love, not "eagle's wing, or insect's eye," was the convincing evidence of divine love:

> A warmth within the breast would melt
> The freezing reason's colder part,
> And like a man in wrath the heart
> Stood up and answer'd "I have felt."

To Coventry Patmore, a devout Victorian poet, the worlds of telescope and microscope were "two deserts." In our own day, T. S. Eliot's poetry is partly a religious protest against scientific materialism.

A second major objection among literary writers has been that science is incompatible with beauty or truth. Keats complains that science would

> Conquer all mysteries by rule and line;

that Newton has unwoven the rainbow and placed it

> In the dull catalogue of common things.

Poe has a similar lament that science is exterminating the lovely beings of mythology and robbing the poet of

> The summer dream beneath the tamarind tree.

Others go far beyond this romantic nostalgia for lost illusions and hold that science deals in half-truths which misrepresent the deep realities of experience. Wordsworth distrusts science as a distorter of truth:

> Our meddling intellect
> Misshapes the beauteous forms of things:—
> We murder to dissect.

Browning suggests that the scientist's devotion to fact insulates him from the joy and beauty of living and thus from vital or total truth. Whitman records how, after listening to "the learn'd astronomer" until his patience was exhausted, he went out

> In the mystical moist night-air, and from time to time
> Look'd up in perfect silence at the stars

—which may be good science after all.

Poets and other writers are by no means unanimous, nor always individually consistent, in rejecting science. Through the centuries hospitality parallels hostility. Dante and Chaucer have each an astonishing range of scientific lore. Later, as a cleavage between this and other interests becomes more apparent, literary men continue to borrow from the world of science. It is a rich source of allusion and metaphor, though for such uses the discredited is quite as acceptable as the up to date. As Stefansson has observed, the ostrich that hides its head in the sand is for literary purposes a more useful creature than any factual *Struthio*. Our weeping crocodiles, death-singing swans, and resurrected phoenixes are survivals from the "unnatural natural history" of long ago. Other images come from scientific developments of the writer's own day, developments sometimes understood and sometimes not. Tennyson affords examples of both. Whitman, Lanier, Melville, and many others draw freely from astronomy, chemistry, geology, not so much for main subject matter as for figure and symbol.

When literary men have been receptive to the ideas as well as to the factual details of contemporary science, it has often been with deep disquiet, with profound regret, or with reservations concerning the parallel validity of the spiritual and the metaphysical. Tennyson is once again a case in point, as we have seen. Matthew Arnold's friend Clough tried to persuade himself that, if the achievements even of the poets rest upon

> Nothing more, nothing less,
> Than a peculiar conformation,
> Constitution, and condition
> Of the brain and of the belly,

then the disillusioned humanist, convinced against his will, could hope that

> It may be, and yet be not.

In contrast, others have accepted science with exultation. Swinburne saw in the growth of science one cause of the death of religion and, in the death of religion, the liberation of man. Meredith, feeling in the stars "that frigidity of brainless ray" called by someone else "the cosmic chill," looked for comfort not to heaven but to earth, and there found inspiration in an evolutionary ladder, which he symbolized by the words Earth, Blood, Brain, and Spirit, each ascending term being strictly a function of those below it.

To turn to a less philosophical sort of borrowing, sensational exploitation of science produces one of the lower forms of literary art—or of subliterary craft. Poe, whose romantic protest was noted above, was a deliberate and often clever practitioner of science fiction. Whether the strange farrago called *Eureka* is a startling cosmological forecast or a sign of incipient madness, Poe certainly kept a calculating eye open for scraps of science and pseudo science to exploit in "tales." Mesmerism, a sort of bogus entomology, the hollow-earth theory, balloon ascensions, the transmutation of metals—all these and more were played up in stories, some good, some pathetically bad. Poe is one progenitor of those "astounding" yarns of today that maintain an ostensible contact with advanced technology.

"Popularization" may not be a popular word among scientists, but it names accurately the sort of writing it stands for. For centuries now the research of scientists has been exciting work. For many decades the public has been increasingly curious and, in a crude way, increasingly informed about the wonders of the laboratory. We all intend to know something about science, and for most of us it is popularizations or nothing. As the complexities of discovery grow more abstruse, interpretation demands more competence. Such names as Jeans, Whitehead, and Bertrand Russell, or Beebe, Sears, and Carson, remind us that among works on science intelligible to laymen, some of the best are written by scientists.

A few scientists, as spare-time explorers of belles-lettres, amuse themselves by noting literary references to their specialties. This hobby occasionally bears fruit in articles on such topics as Shakespeare on geology, botanical allusions in Arnold, or insects in poetry—articles of unequal merit but sometimes of considerable popular interest.

In a broad sense every publishing scientist is a literary man. Luckily, Phineas Fletcher's versified physiology (*The Purple Island* [1633]) and Erasmus Darwin's rhyming botany (*The Botanic Garden* [1789]) have set no lasting fashion. But sometimes a work of science has literary merit more integral than mere poetic ornament. Lyell, Tyndall, and even Charles Darwin can be read by nonspecialists with some pleasure, and the popularizer T. H. Huxley, with delight.

Personal feeling, the lifeblood of imaginative literature, has no proper place in modern scientific writing. Yet emotionless research kindles emotion. Science gratifies and renews curiosity, answers questions and stirs the sense of mystery, arouses petty complacency or cosmic terror. Science is admired, emulated, misunderstood, feared, resented. The science-fiction addict gasping over space-ships, the fundamentalist defending Genesis, the moralist evaluating atomic war, even the scientist contemplating frustration or achievement—all feel while they think, or think at least a little while they feel. Inevitably such responses carry over into literature.

No doubt the science in literature is often outdated, distorted, or misapprehended; but so great a factor in the pattern of modern life must find imaginative as well as theoretical and technological expression. It would be surprising if there were no cultural lag. Modern laymen are pretty well adjusted to a Copernican solar system; we are beginning to feel at home with evolutionary biology and with geologic time; but we are baffled by space-time and the quantum theory. We struggle along behind the advance of science, lugging a burden of mythology, prejudice, sensory limitations, and vestiges of animism. But the burden is inescapable and even indispensable. It consists partly of previous cultural assimilation of science, partly of the very structure of mind and emotion to which the newer science must somehow become related. And literature is one of the vital means by which that relationship is developed. Through poem, novel, drama, essay, we experiment with science until at last we know what to do with it—and are of course confronted with still newer science.

A century and a half ago, early in his career, Wordsworth wrote a prose preface to his and Coleridge's most famous book (*Lyrical Ballads*, 2nd ed. [1800]). In a passage about science, he recognized clearly enough the satisfaction it gave to the scientist. For validity to the layman, he believed that it must find emotional as well as informational significance for daily life:

> If the labors of men of science should ever create any material revolution . . . in our condition . . . , the poet will sleep then no more than at present. . . . The remotest discoveries of the chemist, the botanist, or mineralogist, will be . . . proper objects of the poet's art . . . if the time should ever come when these things shall be . . . material to us as enjoying and suffering beings. If . . . science . . . shall be ready to put on, as it were, a form of flesh and blood, the poet will lend his divine spirit to aid the transfiguration, and will welcome the being thus produced, as a dear and genuine inmate of the household of man.

This emotional validity, this dear genuineness, is what many a thoughtful writer considers utterly alien to science—not merely to scientific procedure but to the meanings of science for man as man. Assimilation continues, but so does protest. The "value" problem is perennial.

For three or four centuries science has been affecting profoundly all areas of Western culture. The Renaissance is commonly said to mark a shift of dominant interest from the next world to this. If that shift is the key to modern thought, then the study of this world would seem to be the characteristic modern study. On such an assumption the time doubtfully foreseen by Wordsworth is here. The problem of poet and scholar, however, is not what Wordsworth expected; it is one of adjustment to naturalistic ethics. The possibility to be faced is that what we call value is a judgment of consciousness upon events in consciousness; that, whether science can deal adequately with values or not, they are conceivable as material phenomena. But if from the nonvalued procedures of the laboratory the necessary inference is that science has nothing to do with values, or even destroys them, then science is culturally and ethically delusive; such critics as Bush (*8*) and Waggoner (*9*) are right, and the problem of the humanist is to maintain and reinstate spiritual values in the face of, not in terms of, naturalism and positivism. The two views seem incompatible, but neither is likely to disappear. Their clash complicates the literary study of science. It also emphasizes that such study cannot stop with the tracing of superficial influences but must face profound philosophical issues.

In 1939 there was organized within the Modern Language Association of America a group to study the relations of literature and science. At each convention since then, a full program of papers has been read, and a mimeographed bibliography of literature-and-science studies has been distributed. Such lists being ephemeral, some demand arose for their publication. Two or three efforts proved abortive. Then, with the assistance of the State College of Washington, a formal issue became possible. About half the 1300 accumulated items were selected and arranged by four active members of the MLA group's bibliography committee: Francis R. Johnson, of Stanford; Hyatt H. Waggoner, of the University of Kansas City; Norbert Fuerst, of Indiana; and Fred A. Dudley of Washington State. The choice of items was simplified by a careful redefinition of scope, for which the main credit belongs to Mr. Waggoner. Many titles dropped were general, not

literary, discussions of science and ethics. Others dealt with the history or philosophy of science or of particular sciences, which are better covered in other bibliographies. To quote the foreword:

> Part I includes not all kinds of studies pertinent to the relations of literature and science, but almost exclusively studies in which those relations are directly discussed. Part II includes not philosophers who have discussed science nor scientists who have influenced literature, but almost exclusively literary figures whose relations to science have been more or less seriously studied. In this area the bibliography is not rigorously selective, but—though doubtless far from exhaustive—is intended to be reasonably complete.

As finally released at the Stanford convention in September 1949, the list is a neat multilithed pamphlet (*10*) of 59 pages. The small edition was sold out within a year, and no reprinting is in prospect. Many of the purchasers, however, were libraries. Copies are available on nearly a hundred campuses and in about a dozen public and half a dozen research libraries.

From the shorter annual list for 1950, a selection (*11*) edited by Fuerst (Indiana) and Williams (Illinois Institute of Technology) was published in *Symposium* for November 1951. General studies are listed first; studies on individual authors or particular periods follow in three chronological groups. In 1952 and thereafter, the list for the preceding year is to come out in May. *Symposium* will thus provide annual selected lists of published works on the relations of literature and science.

No doubt the main users will be literary scholars. But if among our scientific colleagues there are persons curious about such matters, these lists may help them to locate publications of interest. Should such exploration bring about a closer understanding between the two areas of study, the literary scholar may be aided in reducing his ignorance of science.

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Books and Scientific Meetings

R. E. Blackwelder

Society of Systematic Zoology

MOST SCIENTISTS who have attended conventions of the AAAS are familiar with the exhibits of the book publishing houses at the Exposition of Science and Industry, an annual event of large proportions and considerable popularity. Usually about 25 publishers engage separate booths, each displaying his technical publications. Some of these publishers and about 20 to 30 others combine their books in the Science Library, in which books are arranged by subject rather than by publisher. Probably more than 1000 different books are exhibited; the Science Library alone contains 500–800.

It is not claimed that these exhibits contain all the available scientific books. They usually include only the publishers' most recent productions—new books and reprints. Large publishers of technical works generally take advantage of this opportunity to display their current items.

The Science Exposition has proved to be well worth while for both the exhibitors and the delegates. Nevertheless, it is not an ideal place to increase one's knowledge of the available current books in any particular field. For persons who do not know just what books they wish to see, the arrangement by publishers is not always satisfactory. Even after browsing through all the booths, one has no assurance that he has seen all the current books, and except in the Science Library direct comparisons of volumes are difficult or impossible.

In some phases of scientific work, especially in teaching, books are of great interest and importanee. In certain fields of science, such as systematic biology, books are produced in considerable numbers, with a wide range of approach, including advanced works of reference, texts for all levels, technical books for the nonprofessional, popular books for the general reading public, and books for children. A scien-

tist comes in contact with all these in various ways, as author or teacher, critic or reader. Any means that will make the available books better known to scientists is worth a trial.

Systematic zoology embraces the study of kinds of animals, their different natures and distribution, their history and evolution, their distinguishing characteristics and classification. Large numbers of books have been written in this field, especially in recent years—perhaps a thousand are now available. There is no easy way to survey this imposing array of written material and no one place to inquire if there is some one book among the thousand that will serve a particular purpose. Aside from those libraries that endeavor to obtain all books in their specialties, scientific organizations have generally used but one method to acquaint their members with books—that of listing or reviewing new publications. This is seldom a systematic process. It is usually incomplete and sometimes quite restricted in coverage.

Because of the strong interest that has been taken in books in its field, the Society of Systematic Zoology has developed three plans to bring to the attention of biologists the recent books in the basic zoological sciences. One of these plans has been in operation, successfully, for two years; another is being developed as a project for publication in the near future; and the third is to be a new feature at the St. Louis meeting of the AAAS (December 27–30, 1952). All three plans result in publicity for the books, with two of them tending to give complete presentations of the available items in the field.

Under the first plan, an exhibit differing only in scope, arrangement, and utility from book displays in the Exposition is held at each meeting of the society. The society has accumulated a specialized library that is approaching completeness in the field of systematics, and is also rich in other aspects of zoology—especially in textbooks. The books, which are generously donated by the publishers for the purpose, are exhibited as the property of the society in a manner designed to emphasize their nature and the part of the animal kingdom treated, rather than the publisher or the author. They are placed in a lounge at the hotel headquarters of the society, and an invitation is extended to all zoologists to examine, peruse, and discuss the volumes, or to take notes, or simply to while away an hour with a book of interest.

These book exhibits are held not only at the AAAS meetings but also at other meetings of zoologists throughout the country and throughout the year, whenever appropriate. Selections of books are sent to meetings of more specialized societies. Even this multiple exhibit, however, reaches only a small minority of the members of the society, scattered as they are throughout the United States and a number of foreign countries.

In order to bring these benefits to the rest of the membership and to extend the service rendered the cooperating publishers, a complete list of the books is published by the society (*News Letter*, [4], [April 1951]; *Systematic Zoology*, **1**, [1], [March 1952]). Here the listings are by general subject matter, as well as by publisher. Besides the subject and publisher, information given includes the title, the publisher's address, the number of pages, the year of publication, and the price. More than 350 works are now included in this specialized library.

It is impossible to mention more than a few of the books here, but examples will indicate the scope of the collection. Reference works are given a prominent place—the five volumes of Neave's *Nomenclator Zoologicus* and the familiar *Zoological Record*, so essential to all taxonomic work. The *Record* is represented by three complete volumes, as well as by sets of the 19 sections in which it is also published.

There are eleven recent journals. Among them are the *Wasmann Journal of Biology*, the *Bulletin of the Serological Museum*, and the *Bulletin of Marine Science of the Gulf and Caribbean*.

Among the fields of zoology represented are paleontology (Twenhofel and Shrock, *Invertebrate Paleontology*, and Smith, *The World of the Past*); comparative anatomy (Romer, *The Vertebrate Body*, and McEwen, *Vertebrate Embryology*); evolution (Blum, *Time's Arrow and Evolution*, and Jepsen, Mayr, and Simpson, *Genetics, Paleontology, and Evolution*); genetics (Riley, *Introduction to Genetics and Cytogenetics*, and Dunn, *Genetics in the 20th Century*); ecology (Clements and Shelford, *Bio-ecology*, and Hesse, Allee, and Schmidt, *Ecological Animal Geography*); history (Meyer, *The Rise of Embryology*, and Locy, *Biology and its Makers*); natural history (Bates, *The Nature of Natural History*, and Beebe, *The Edge of the Jungle*); methods (Baker, *Cytological Technique*, and Welch, *Limnological Methods*); general biology and zoology texts; conservation; and books on animals for children.

The more specialized systematic books include works on invertebrates (Hyman, *The Invertebrates, I, II, III*, and Pratt, *A Manual of the Common Invertebrate Animals*); protozoans (Kudo, *Protozoology*, and Jahn, *How to Know the Protozoa*); parasitology (Chandler, *Introduction to Parasitology*, and Goody, *Soil and Freshwater Nematodes*); mollusks (Morris, *A Field Guide to the Shells*, and Keep and Baily, *West Coast Shells*); arachnids (Gertsch, *American Spiders*); insects (Ross, *A Textbook of Entomology*, and Klots, *A Field Guide to the Butterflies*); fishes (Breder, *Field Book of Marine Fishes of the Atlantic Coast*, and Hubbs and Lagler, *Fishes of the Great Lakes Region*); amphibians and reptiles (Pickwell, *Amphibians and Reptiles of the Pacific States*, and Ditmars, *A Field Book of North American Snakes*); birds (Peters, *Check-list of Birds of the World*, and Saunders, *A Guide to Bird Songs*); and mammals (Orr, *Mammals of Lake Tahoe*, and Cahalane, *Mammals of North America*).

These are but a few of the many books in each category. The special fields of college zoology and biology texts are well represented, for many systematic zoologists are also teachers of zoology or biology. One

botanical book has found a place in this collection: Fernald's eighth edition of Gray's *Manual of Botany*, long familiar to zoologists and much used by them.

This library contains much more than purely systematic works, although some descriptive monographs are also included. Its scope is larger than the field normally covered by the Society of Systematic Zoology, in order to include subject matter of interest to research taxonomists, ecologists, evolutionists, anatomists, zoology teachers, amateur naturalists, and others interested in animals. The exhibit has increased in popularity at successive meetings—to such an extent that it has now become a regular feature of all SSZ meetings.

The second plan is an outgrowth of the first. There is still the need for means of finding out what books are available on a particular subject. It is believed that a list of all zoological books in print (that is, currently available from the publishers), classified by subject matter, and giving information on price, size, where to order, the edition available, etc., would prove useful, and that it could be produced with the help of the publishers. Preliminary work is now being done on this project.

Many new books are reviewed in current periodicals, in such special journals as the *Quarterly Review of Biology* and the *U. S. Quarterly Book Review*, in such general ones as *The American Scientist* and THE SCIENTIFIC MONTHLY, and in more specialized ones such as *The Journal of Mammalogy* and the *Annals of the Entomological Society of America*. Often a book is reviewed in several journals. The reviews range from mere notices of publication to careful critiques.

The large number of reviews indicates that they are useful, but their unsystematic arrangement, the great variety of publications issuing them, and the general lack of indexing make them a difficult source of information regarding any specific book. For keeping up with current publications in a general way they are, however, quite useful.

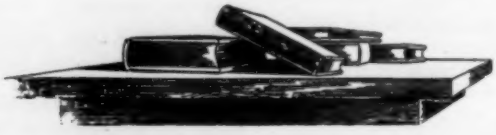
In the list of books in print, envisioned above, it would be useful to list under each book the reviews of it that have been published. The reader could then readily ascertain the opinions of the reviewers in order to judge whether a particular book would meet his needs. But the question at once arises: Is the considerable work of assembling the references to all these reviews justified by the use that would be made of them? On the answer to that question hinges this feature of the project.

The third plan for increasing knowledge of, and interest in, books is also coupled to the annual meeting of the society. This is to take the form of a special panel discussion of one or more specific books, with the author of the book and a selected group of specialists from related fields as participants. The intent is to draw from the author ideas on the implications of his book in other fields of study, to bring out the special contributions of the book itself, and to determine the extent to which the book's conclusions are supported by data from other fields.

Scheduled for the 1952 meeting in St. Louis is a discussion of *Time's Arrow and Evolution*, by H. F. Blum, one of the most significant, as well as one of the most technical, of the recent books on evolution. Despite the fact that it has been called a "mind-stretching book," it is hoped that discussion, guided by the author, will enable the attending minds to understand at least part of its important message.

Also definitely scheduled is another important discussion of evolution from the systematic zoologists' viewpoint rather than from the biochemists'. *The Meaning of Evolution*, by G. G. Simpson, has proved to be one of the most popular books on this subject, having already passed through at least five editions. By "popular" we do not mean to imply that it is elementary, but rather that its style is so lucid, its data are so authoritative, and its language is so nontechnical that it can be understood by any educated person and enjoyed by all.

One or two sessions are also being planned to consider textbooks in general zoology and general biology. In these, two or three books written from different viewpoints but on the same level will be contrasted. With help from the authors and other panel members, the advantages of the ecological approach, the systematic approach, and the approach through principles will be compared. It is hoped that teachers of elementary college courses will find these sessions of interest and assistance in planning their own approach to the subject.



News and Notes

Scientists in the News

George Aronis, geologist in the Greek Ministry of National Economy, and **George Marinos,** assistant professor of mineralogy at the University of Athens, are in this country for six months of in-service training in economic geology and hydrology under the guidance of the U. S. Geological Survey. The Survey is also arranging an itinerary for **Carlos Acosta del Campo,** Mexican hydrologist, to enable him to study problems of salt water encroachment, desert and karst hydrology, and well-drilling techniques.

Eleanor A. Bliss, assistant professor of preventive medicine at the Johns Hopkins University Medical School has been appointed dean of the Graduate School at Bryn Mawr College. She will succeed **Lily Ross Taylor,** who is retiring at the end of the academic year. Well known for her research in bacteriology, Dr. Bliss has been on the staff of Johns Hopkins since 1925.

George A. Busch has been appointed visiting professor of physics at Carnegie Institute of Technology, to work mainly on the program of research in low-temperature phenomena. Prior to joining the Carnegie faculty, Dr. Busch taught physics at the Swiss Federal Institute of Technology for 19 years.

Leonard Carmichael, psychologist, and president of Tufts College since 1938, will become the seventh secretary of the Smithsonian Institution next January, succeeding **Alexander Wetmore,** who reached the retirement age last June. Dr. Carmichael is a member of the National Academy of Sciences, a former president of the American Psychological Association, former chairman of the American Council on Education, and during World War II served as director of the National Roster of Scientific and Specialized Personnel. Dr. Wetmore, who has been with the Smithsonian since 1925 and secretary since 1945, wishes to devote his full time to his research in ornithology.

S. Chandrasekhar, of the Yerkes Observatory, University of Chicago, has delivered six special lectures as visiting professor of astrophysics at California Institute of Technology. While in California Dr. Chandrasekhar was awarded the Catherine Wolfe Bruce Gold Medal of the Astronomical Society of the Pacific.

R. L. Cushing has been appointed acting director of the Pineapple Research Institute of Hawaii, succeeding **E. C. Auchter,** who will retire on May 31 because of ill health. Dr. Auchter will continue, however, as consulting scientist.

Joseph Deinet, vat dye specialist, has retired after more than 25 years of continuous service with the Du Pont Company. A research chemist in the anthraquinone division of Jackson Laboratory, Deepwater Point, N. J., Mr. Deinet is one of the few remaining pioneer anthraquinone vat dye chemists. It was because of this early pioneering work that a Modern Pioneer Award was granted to Mr. Deinet in 1940 by the National Association of Manufacturers.

John D. Dwyer, associate professor of biology at Siena College, Loudonville, N. Y., will spend three months at the Museum d'Histoire Naturelle, Paris, working on the systematics of the Caesalpiniaceae. His research will be supported by a grant from the National Academy of Sciences.

At the invitation of the Israeli government, **John H. Garlock,** chief of the Surgical A Service at Mount Sinai Hospital and clinical professor of surgery at Columbia University, has been visiting the major hospitals of Israel, conducting teaching operative clinics and giving lectures in each institution. He was accompanied by his anesthetist, Sidney Lyons, who gave courses in modern anesthetic methods.

The first annual Goldsmith Award, made by the *Bulletin of the Atomic Scientists,* has been given to **Walter Gellhorn,** of Columbia University, for his book *Security, Loyalty, and Science.* Under the terms of this award, established in memory of the late Hyman H. Goldsmith, who was co-editor of the *Bulletin* until his death two years ago, the judges have considered Gellhorn's book the "best contribution to the clarification of relations between science and politics."

Lawrence A. Hoffman has been appointed assistant professor in the Department of Geography at Ohio State University. During 1950–51 Dr. Hoffman was a Fulbright scholar in India. He returned to this country in January following extended stopovers in southeast Asia and Japan.

Horace S. Isbell, head of carbohydrate research in the National Bureau of Standards, has received the Hillebrand Award of the American Chemical Society's Washington Section for major contributions to the chemistry of sugar and for the synthesis of radioactive carbohydrates.

Eugene L. Jackson, medical director of the A. H. Robins Co., Inc., of Richmond, Va., since 1946, has been elected vice president of the company. Dr. Jackson was formerly chairman of the Department of Pharmacology at the Emory University School of Medicine, Atlanta.

Robert T. Knapp, professor of hydraulic engineering at the California Institute of Technology, has gone to London to deliver the annual James Clayton Lecture before the Institution of Mechanical Engineers. He is speaking on "Cavitation Mechanics and its Relation to the Design of Hydraulic Equipment" and will repeat the lecture at an Institution meeting in Edinburgh. While in Great Britain he will visit the Admiralty hydraulics laboratories and the universities of Wales and Cambridge. Before returning to Caltech,

Professor Knapp will visit hydrodynamics laboratories and facilities in Zurich, Madrid, Paris, and Grenoble.

Frank H. MacDougall is retiring in June as chief of the division, and professor of physical chemistry, at the University of Minnesota.

Sister Mary Therese, of Mundelein College, through a contract with the Office of Naval Research, will devote the summer to research on planetary nebulae at Mt. Wilson–Palomar observatories in Pasadena.

A four-year university scholarship, offered by the Radio Corporation of America and valued at $2400, has been awarded to a graduate of RCA Institutes, **Kurt F. W. Moeller,** now majoring in electrical engineering at the Polytechnic Institute of Brooklyn.

Rufus Oldenburger, mathematician-engineer of the Woodward Governor Company, Rockford, Ill., is giving a series of lectures in Paris at l'Institution des Arts et Métiers, Société Française des Mecaniciens, Société des Radioelectriciens, and the Société d'Electronique et d'Automatisme, on "Mathematical Engineering Analysis."

Ralph G. Owens has been named dean of engineering at Illinois Institute of Technology. Dr. Owens, who has served as assistant dean of engineering since February 1951, replaces **John T. Rettaliata,** who was recently named president.

Howard M. Phillips, professor of biology and chairman of the Department of Biology at Emory University, has been appointed dean of the Graduate School. **W. D. Burbanck** has been appointed chairman of the Department of Biology.

Aaron L. Shalowitz, Carl I. Aslakson, and **Henry W. Hemple,** of the Coast and Geodetic Survey, were recently awarded the 1952 Department of Commerce Exceptional Service Gold Medal for outstanding contributions to the field of science and technology. Mr. Shalowitz has served in the Washington office of the Survey since 1921. He is at present a special assistant to the director and is technical adviser to the Department of Justice in the California submerged lands oil case. He is editor of the technical *Journal of the Coast and Geodetic Survey,* and also editor-in-chief of the quarterly journal of the American Congress on Surveying and Mapping. Captain Hemple is serving as chief, Division of Geodesy. Commander Aslakson has given outstanding service to the National Military Establishment relative to the measurement of distances by electronic methods. At present he is consultant to the USAF on geodetic survey problems in establishing control for guided missile tests at the Air Missile Test Center, Cocoa, Fla.

William L. Straus, Jr., has been appointed professor of physical anthropology at The Johns Hopkins University. Since 1927 Dr. Straus has been a member of the faculty of The Johns Hopkins School of Medicine, where he has been associate professor of anatomy since 1943.

Charles Allen Thomas, president of the Monsanto Chemical Co., and chairman of the Board of Directors of the American Chemical Co., will be general chairman of the Local Committee in charge of arrangements for the St. Louis meeting of the AAAS in December. To assist him, **Leslie James Buchan,** dean of faculties at Washington University, has accepted the chairmanship of the Committee on Exhibits; **Warren K. Begeman,** director of technical and adult education, St. Louis Board of Education, will be chairman of the General Service Committee; and **Howard A. Marple,** director of advertising, Monsanto Chemical Co., will head the Committee on Public Information.

Douglas M. Whitaker has been appointed to the newly created position of provost of Stanford University. Last year Dr. Whitaker left the post of NRC chairman, to become dean of the Faculty of Humanities and Sciences at Stanford.

Education

The **American Society of Tool Engineers** is extending its program of providing financial aid to students in engineering schools by enlisting the financial assistance of industries in areas where ASTE chapters are located. The program is already under way in Boston, Detroit, Worcester, Mass., and New Haven, Conn.

The College of Medicine of the **State University of Iowa** has announced the following appointments effective July 1: Henry B. Bull, of Northwestern, to be professor and head of the Department of Biochemistry; Charles D. May and Franklin Top, of the University of Minnesota, to be professors and heads of the Departments of Pediatrics and Hygiene and Preventive Medicine, respectively. John Randall was appointed professor and head of the Department of Obstetrics and Gynecology Apr. 1. The following will retire to part-time service on July 1: Robert B. Gibson, Ira H. Pierce, Milford E. Barnes, Philip C. Jeans, and Henry A. Mattill.

Northwestern University Medical School is conducting a series of lectures on Tuesday evenings, at Thorne Hall on the Chicago campus, on the history of medicine. The subjects are of popular as well as professional appeal, and the sessions are open to the public free of charge.

Simmons College will give postgraduate summer courses in Home Economics (June 23–Aug. 8); Library Science (June 23–Aug. 8); and Nursing (June 23–Aug. 1).

In honor of the late Bryon M. Hendrix, professor of biological chemistry (1922–52), the **University of Texas** Medical Branch has opened a Seminar Room in the new Gail Borden Laboratory Building.

Timber Engineering Company, 1319 18th St., N. W., Washington 6, D. C., will hold a glue school May 5–9, for training industry and government personnel in the use of modern adhesives in defense production. Special attention will be given to glues for boat, ship,

and barge construction. Applications should be filed at once.

Wayne University will establish a Materials Management Research and Training Center based on recommendations made by a committee representing the American Material Handling Society, the American Society of Mechanical Engineers, the Detroit Board of Commerce, the Society of Industrial Packaging and Materials Handling Engineers, the Material Handling Institute, Inc., and the Michigan Industrial Training Council. The first contribution toward financing the project was $5000 from the Evans Products Company, of Plymouth, Mich., which will contribute a total of $25,000 over a five-year period. Spencer A. Larsen has been named director of the center.

Grants and Fellowships

The **American-Swiss Foundation for Scientific Exchange,** Nutley, N. J., has re-elected C. R. Scholz president; H. M. Wuest, of Montclair, N. J., founder of the organization, is honorary president. During the six years of its activity, the foundation has sent 22 American scientists to Switzerland and brought 33 Swiss scientists to this country. Seventy-one postgraduate students were exchanged. The foundation is planning to send several American university presidents to Switzerland for firsthand impressions of Swiss higher education, and the president of the Federal Institute of Technology, Zurich, will visit this country. Funds for the exchange of scientists come from private sources.

The **National Science Foundation** has awarded 624 graduate fellowships in the natural sciences for the academic year 1952–53. The fellows were selected from about 3000 applications, and the awards went to 569 predoctoral fellows and 55 postdoctoral fellows. A total of 169 (27%) went to first-year graduate students, in sharp contrast to previous federal fellowship policies. Announcement concerning fellowships for 1953–54 will be made about *Oct. 1, 1952,* and application forms will not be available until that time.

During the first nine months of the fiscal year 1952, the Biochemistry Branch of the **Office of Naval Research** has awarded 22 new contracts. These contracts have been made for research in various fields of biochemistry, are distributed among 17 universities and nonprofit institutions for periods of one to four years, and represent a sum of $380,016. In addition, 62 existing contracts for research in biochemistry were extended for periods of one to three years.

Six research fellowships or assistantships are available in the new Institute of Biophysics at **St. Louis University.** Stipends vary from $1200 to $3500. Applications for fellowships should be addressed to the dean, Graduate School, 221 N. Grand Blvd., St. Louis 3, and for assistantships to the Institute of Biophysics, 3546 Caroline St., St. Louis 4. B. J. Luyet, who has been on the staff of the Department of Biology since 1931, is director of the institute.

In the Laboratories

Roger Adams, president of the AAAS in 1950, was one of three new directors elected to the board of **Abbott Laboratories.** The others were Harold D. Arneson and Robert D. Coghill. James F. Stiles, Jr., was elected chairman, Ernest H. Volwiler was re-elected president and general manager, and George R. Cain was re-elected executive vice president. Elmer B. Vliet, who has been director of control, was named vice president and scientific administrator.

Los Alamos Scientific Laboratory has added the following scientists to its staff: Wade Blocker and Robert W. Kenney, physicists, Weapons Division; Harvey I. Israel, biophysicist, Health Division; Michael M. Shurman and Grover M. Taylor, physicists, GMX Division; and Robert G. Thomas, physicist, Experimental Physics Division.

Magnecord, Incorporated, has appointed George C. Kent, formerly design engineer for Revere Camera Company, and William E. Daly, former development engineer with Shure Brothers, senior mechanical engineer and electrical development engineer, respectively.

Charles H. Hofrichter, Jr., has been appointed chief of the research section, Research and Development Department, Olin Cellophane Division, **Olin Industries, Inc.** Dr. Hofrichter is a former Du Pont research chemist.

Radiation Counter Laboratories are now occupying their new manufacturing laboratory at 5122 W. Grove St., Skokie, Ill. The plant is devoted solely to the manufacture of instruments for the measurement of radioactivity.

Walter Reed Army Medical Center has established a Case History Unit in its Army Prosthethics Research Laboratory to record studies made of amputee patients from the time they are first eligible for cineplastic surgery until they leave the hospital. Albert Clark, Korean veteran, will serve as unit testing engineer, under the supervision of Fred Leonard, chief of the testing branch.

Remington Rand Laboratory has appointed John O'Shea, retired Naval officer and former manager of the special products division of Thomas A. Edison, and Ivan Sattem, formerly an associate professor of engineering at West Point and chief engineer with the New York State Power Authority, special assistants to Leslie R. Groves, vice president in charge of the laboratory.

U. S. Rubber Company has named C. D. McCleary manager of basic research in organic chemistry. He will be succeeded in his post as manager of process development by J. N. Judy, who will be succeeded as manager of technical service laboratories by C. G. Durbin. Ivan Mankowich has been appointed manager of reclaim development.

Meetings and Elections

At its meeting in Washington in March, the **Aero Medical Association** named Bertram Groesbeck, Jr., president-elect, and Armand Robert, Alberto Hurtado (of Lima, Peru), Wilbur R. Franks, Harold B. Dye, and Percy B. Wiltberger vice presidents. William R. Stovall took office as president for 1952, and Thomas H. Sutherland was re-elected secretary-treasurer-business manager. The association's Longacre Award was presented to Frederic C. Bartlett, of Cambridge, Eng., and the Lyster Award to Kenneth A. Evelyn, of Montreal. The new Arnold D. Tuttle Award, established by United Air Lines in memory of its late medical director, went to Edward H. Lambert, of the Mayo Clinic.

At the recent annual meeting of the **American Association of Physical Anthropologists** in New York, George B. Barbour presented the first copy off the press in South Africa of the last work of the late Robert Broom, *The Swartkaans Ape-Man, Paranthropus cassidens*. Dr. Barbour also reported the discovery of additional important finds at the Swartkrans site, where T. J. Robinson has unearthed two crushed skulls, several fine mandibles, and numerous teeth. One juvenile mandible is almost complete, and another less perfect is notable as being of the youngest dental age of any australopithecine specimen thus far found. A nearly erupted lower canine is indistinguishable in shape, size, or any other feature from a Bantu canine in the same state of growth. In general, the canines of *Plesianthropus* and *Paranthropus crassidens* show as great a difference in size and morphology as is known among all modern and fossil forms of man, including the australopithecines themselves. There has been a tendency to infer that the australopithecines from the various sites may be hardly more than variants of a single genus, and essentially contemporaneous. Both from the anatomical and geological viewpoint, this inference is still premature.

The **American Phytopathological Society**, Pacific Division, will hold its annual meeting at Oregon State College June 19–21. In addition to the usual sessions for presentation of papers, symposia on "Nematodes" and "Legume Viruses" will be held.

A **Conference on Soil Stabilization** will be held at MIT June 18–20 to examine current problems in the field. Sponsors with MIT are the Navy Bureau of Yards and Docks, the Army Corps of Engineers, the Highway Research Board, the Massachusetts Department of Public Works, and the U. S. National Council on Soil Mechanics and Foundation Engineering. For additional information, address Harl P. Aldrich, Jr., Room 1-336, MIT.

Among the concluding events in observance of its semicentennial, the **National Bureau of Standards** acted as host to physicists specializing in the field of mass spectroscopy. The meeting, held Sept. 6–8, was international in scope and attendance, and J. Mattauch, of the Max Planck Institute at Mainz, Germany, opened the first session, on mass spectroscopy of high resolution for the accurate measurement of atomic masses. The sessions on Sept. 7 were devoted to experiments in cyclotron resonance, conducted by the Brookhaven National Laboratory and the bureau. Isotope separators were reviewed by J. Koch, of Copenhagen, and J. Kistemaker, of Amsterdam; other subjects considered included the study of nuclear reactions by mass spectrometry, ionization and dissociation by electron impact, effects of space charge, etc.

On Oct. 26–27, 350 members of the Institute of Mathematical Statistics met to participate in eight technical sessions, to hear two invited addresses, and to witness a demonstration of SEAC—the bureau's Eastern Automatic Computer.

More than 100 physicists attended the symposium on electron physics Nov. 5–7. L. Marton, of the NBS electron physics laboratory, functioned as chairman, and the Office of Naval Research cooperated with the bureau in the organization of the meeting. Two of the seven sessions of the symposium were devoted to electron scattering, four to electron optics, and one to experimental techniques. Noteworthy among the 47 papers presented was the discussion by W. Glaser, of Vienna, of "The Fundamental Problems of Theoretical Electron Optics," in which he advocated a wave-mechanical approach to electron-optical problems. W. Botke, of Heidelberg, reviewed experimental electron scattering, a subject that was further developed by H. Feshbach, of MIT, who submitted new and precise calculations of the scattering of electrons and positrons by point nuclei. D. Gabor, of London, discussed progress in diffraction microscopy. Many of the papers in electron optics attempted to reconcile wave and particle classifications and thereby open up new fields for investigation.

A symposium on Williams Electrostatic Storage Dec. 13–14 brought to the bureau 115 scientists, representing practically every electronic computer activity on this continent and in England. The opening session dealt with SEAC as a case study in Williams storage, and successive sessions dealt with storage mechanisms, circuit problems, and cathode-ray tubes. The National Bureau of Standards Eastern Automatic Computer was, of course, on hand throughout the meeting, and one of the special events was an open house in the SEAC building.

The **National Wildlife Federation** re-elected Claude D. Kelley president, Karl T. Frederick and Robert W. Miller vice presidents, and Lloyd F. Weed and Louis W. Wendt, secretary and treasurer, respectively. Dean W. Davis was elected a vice president.

A **Southwest Regional Conference on Pre-Professional Health Education** will be held May 15–17 at the University of Texas Medical Branch, Galveston, under the auspices of the Texas Academy of Medicine, the National Honorary Pre-Medical Society, and the Medical Branch. Representatives from national organizations in health fields will participate.

Book Reviews

General Education in Science. I. Bernard Cohen and Fletcher G. Watson, Eds. Cambridge, Mass.: Harvard Univ. Press, 1952. 217 pp. $4.00.

General education is a religion that is fast acquiring the status of an established church. This book is a contribution to its ecclesiastical literature, being 15 essays prepared by competent educators for the Harvard Workshop in "Science in General Education" (1950). Although understandably exhortatory in tone, each essay has merit as an indication of honest effort to say something significant about science teaching and its needs.

When one has lived for years, as I have, in *sin*—the sin of specialization—the reading of this book is likely to arouse mixed emotions. First, there comes the spirit of proud defiance, then of contrition, and finally of conversion as one evangelist after another preaches the gospel of integrated education. If there is backsliding, it is but an indication of the utter depravity of the old ways into which one has heedlessly fallen.

The 15 defenders of the faith are united in their opposition to "the traditional specialist's courses" in science. In their concerted aim to make science intelligible to more nonscientists and to make scientists better citizens, historians, and philosophers, their purpose is noble. On how to attain their desired goal, each man's suggestions are worth considering: surely, any program that includes among its aims the cultivation of *better thinking* by students deserves attention! General education hopes to liberate liberal education, to have students "know the scientific enterprise as a whole," to divest science of its priestly robes, to disengage it from its beautifully deceptive aura, to restore to it a history and a philosophy, to debunk it of its fictitious "scientific method," to release it from the "curse of coverage," and replace coverage by well-chosen case histories, in the study of which the student is led into scientific thinking, or a reasonable facsimile thereof. If the movement avoids playing the role of a Don Quixote, it may have in it the strength to accomplish what has always seemed to this reviewer as the avowed but unattained purpose of education generally. New ideas, new slogans, and new blood should be welcomed in any process as important as education, since each generation reviews the faults of the past and tries to modify its own course in directions that give promise of satisfactory advancement. One detects frequently the note of humility as these essayists recognize the vastness of the task undertaken.

In a short review, it is not possible to give many of the quotable statements the volume contains, nor to write adequate criticisms of each man's contribution. The place of science in our civilization and the reasons for believing that changes in science education are much overdue are viewed from various angles by Messrs. Dubos, French, Sears, LeCorbeiller, Goudsmit, and Fuller. The part played by philosophy in the teaching of science is treated by Kemble and Frank; by history, in three essays by Cohen, Nash, and Kilgour. Two sane and realistic contributions by the biologists Castle and Erikson appealed to your reviewer as particularly acceptable. The book concludes with two chapters by Dyer and Watson on the difficult problem of evaluating the results of the new approach to science teaching. Throughout the "commercials," there are valuable suggestions and stimulating ideas.

If, two decades from now, science teaching has taken on a new complexion, if it serves the populace better, makes more civilized scientists and more science-minded citizens among the laity, it may come to pass because of the efforts of these men, and others, who honestly and earnestly seek for better ways to do this perennial job of educating that has never been done well enough. Much as they tend to blame the present sorry plight of the world, so far as education is responsible for it, upon the growth of narrow specialization, most of them frankly admit that general education is not a proved panacea for all our ills, but that it still stands in the position of a promising experiment. Education is still likely to remain a process that depends primarily upon the teacher's breadth of interest, devotion, and ability to share with students his best insights.

RICHARD M. SUTTON
Department of Physics, Haverford College

Physics and Mathematics

Astrophysics: A Topical Symposium. Commemorating the fiftieth anniversary of the Yerkes Observatory and a half-century of progress in astrophysics. J. A. Hynek, Ed. New York: McGraw-Hill, 1951. 703 pp. $12.00.

This volume, most appropriately bearing the subtitle *A Topical Symposium*, was composed to commemorate the fiftieth anniversary of Yerkes Observatory and half a century of progress in astrophysics. The contributors, who all at one time or another were connected with Yerkes, were each asked "to survey his field, to describe its growth during the past fifty years, to examine its particularly challenging problems; and to address a hypothetical first-year graduate student, well versed in fundamentals but by no means a specialist." It is amazing, even when one takes into account the galaxy of contributing astrophysicists, to what degree practically all of them have succeeded in doing exactly this. The result is a most stimulating survey of practically the whole field of astrophysics, and this volume can certainly be used as a textbook for graduate courses in the subject. The fact that the various contributors have clearly indicated the many problems with which astrophysics is still confronted should assist research workers in the field, and for a long time to come this book should provide a powerful stimulus to astrophysicists.

The material is divided into an introduction followed by four large sections. In the introduction, which surprisingly bears the title "On the Development of Astrophysics during the Last Half Century," Strömgren gives a survey of the state of astrophysics around 1900. Only by a comparison of the situation then with the present is it possible to see the great heights reached by astrophysics in as short a period as 50 years.

The four main sections deal, respectively, with "Spectroscopic Astrophysics," "Physics of the Solar System," "Physics of Binary and Variable Stars," and "Physics of Cosmic Matter." The division seems to me rather artificial and not always understandable. For instance, although one can easily see why Greenstein's chapter on interstellar matter is classified under physics of cosmic matter, it is difficult to understand why Chandrasekhar's contribution dealing with the structure, composition, and source of energy of the stars should also fall into the same category, and one wonders whether, in that case, all chapters could not have become part of this section of the volume.

In the first chapter of Part One Keenan and Morgan give a historical survey of the classification of stellar spectra, showing how this branch of astrophysics has developed and discussing what spectra offer special problems of classification. In the next chapter Aller describes how stellar spectra are obtained, how spectral lines are formed, and what information can be obtained from the spectra. Aller restricts himself to "normal" spectra. In the third chapter Struve reviews the fascinating problems posed by some "peculiar" spectra. He has chosen for discussion the following 8 topics: Be stars, close binaries with gaseous rings, spectra with peculiar line intensities, Wolf-Rayet stars, T Tauri variables, stars with extended atmospheres, novae, and emission lines in long-period and Cepheid variables. As could be expected from this author, the chapter is extremely stimulating and full of pointers to as yet unsolved problems. The fourth chapter is devoted to a discussion by Swings of molecular spectra. As this field is still developing fast, Swings devotes most of his account to suggestions of possible astronomical observations, laboratory and theoretical investigations, and desirable theoretical astrophysical investigations. Part One closes with a chapter by Strömgren in which he discusses how spectroscopic astrophysics has progressed during the past 50 years.

Part Two, treating the physics of the solar system, contains three chapters. In the first of these Pettit discusses the sun, its radiation, sunspots, chromospheric phenomena, prominences, the corona, and related topics. There follows a discussion by Bobrovnikoff of our knowledge, and in many cases our lack of knowledge, of comets. The last chapter contains an extremely interesting, but rather controversial, paper by Kuiper on the origin of the solar system. I hope to discuss this theory in detail elsewhere in the near future, but, interesting as Kuiper's considerations are, it is regrettable that he—who has contributed so largely to the recent increase of knowledge about characteristics of the solar system—did not give us instead an account of the physical nature of the planets. As an alternative, I feel that it would have been valuable to have given a critical survey of developments in the field of theories on the origin of the solar system, which would, at the same time, have been more in accordance with the general aim of the volume. During the past 50 years there have been proposed such widely diverging theories as the different tidal theories, Birkeland's and Alfvén's electromagnetic theories, and von Weizsäcker's and Kuiper's versions of Kant's cosmogony, to name only a few, and a critical survey would have been of the utmost importance.

Physics of binary and variable stars are dealt with in Part Three. Van Biesbroeck opens this section with a chapter on the visual binary stars and stellar parallaxes, and Hynek discusses spectroscopic binaries and outlines the problems connected with any theory about the origin of binary stars—a problem justly described as a pivotal one in cosmogony. In Chapter 11 Pierce discusses briefly how eclipsing binaries provide us with information on the physical properties of the stars. Cecilia Payne-Gaposchkin ends this part with an account of our present knowledge about the intrinsic variable stars. She discusses in turn all 5 main groups of the Great Sequence, classical Cepheids, cluster variables, RV Tauri stars, long-period variables, and semiregular variables.

Part Four contains only two chapters, but both are extremely interesting. Greenstein deals with interstellar matter, discussing the whole field of emission nebulae, reflection nebulae, interstellar reddening, interstellar grains (I always wonder at the reluctance of so many astrophysicists to use the term "smoke particles," introduced by van de Hulst), interstellar hydrogen, galactic radio noise, interstellar molecules, stellar evolution, and interstellar polarization. The last chapter is one by Chandrasekhar on the structure, composition, and source of energy of the stars. As we have learned to expect from Chandrasekhar, this contribution is original, clear, and comprehensive. In fact, if I should have to state my preference for one of the chapters of the book, this would be the one I should choose. Chandrasekhar deals with the following problems: physical conditions in the interior of a star, source of stellar energy, composition of the stars, structure and composition of the white dwarfs, and stellar evolution.

It can be seen from the account given here that this volume covers an extremely wide field, and the editor must be congratulated on achieving such a great amount of uniformity. Any review of a book of this kind must of necessity have a strong personal flavor, and the special stress on certain chapters and more casual mention of others are due purely to personal interests. However, it should be clear from the foregoing that there is enough choice in the volume to satisfy practically anyone who is at all interested in astrophysics. The contributions that appealed most

strongly to me were those of Chandrasekhar, Struve, Swings, and Bobrovnikoff—partly because of their subject matter and partly because of the clarity with which existing problems were mentioned.

The volume promises to become a classic in the field, and one can only be envious of all astronomers who belong to the family of Yerkes scientists, since a school boasting a group of people like the contributors to this book must necessarily produce a never-ending line of outstanding astrophysicists. It will be of the greatest interest to see how much of the material presented in this topical symposium will still be considered correct when the second volume appears to commemorate the Yerkes centenary.

The book contains three indexes—name, star, and subject—which should enhance its usability. It is to be regretted that its price is practically prohibitive so far as European astrophysicists are concerned, but with present-day exchange rates and costs of book production this could hardly have been avoided.

D. ter Haar

Department of Natural Philosophy
University of St. Andrews, Scotland

Studies in Large Plastic Flow and Fracture: With Special Emphasis on the Effects of Hydrostatic Pressure. P. W. Bridgman. New York–London: McGraw-Hill, 1952. 362 pp. $8.00.

This is an important book for those interested in the mechanical strength of solids. Its principal purpose is to consolidate and discuss a large amount of experimental material gathered by Professor Bridgman and his small group of assistants at Harvard University during and following the recent war. Actually, various experiments done prior to that period are included—some from as far back as 1912. A list of 42 publications and government reports is given as the source material. A few results postdating the publications are included. The information on fracture strength and resistance to plastic deformation thus provided is outstanding and unusual, both with respect to the variety of materials studied and with respect to the extreme range of essentially static conditions of plastic strain and of stress.

The substance of the book is a series of deformation studies some of which employ hydrostatic pressures as large as 400,000 psi. For each, the author's narrative of the experimental work is followed by his analysis of the results and his reflective comments in some detail. The experimental work and numerical results are of major permanent value, and readers will find the presentation of these features clear and remarkably interesting. Pertinent colorful detail is included in sufficient amount so that one feels he is witnessing these rare experiments. For example, when a brittle solid with an internal cavity is subjected to large hydrostatic pressure, failure at the walls of the cavity generally begins with forceful ejection of tiny spicules. In a later chapter, it is found that shear fractures can be made to occur under nearly hydrostatic pressure such that they heal immediately, but not without a variety of strange noises voiced in protest against the Bridgman shear strains of 10,000 radians or more.

The numerical results are frequently of arresting interest. One might expect plastic distortion, whether under compressive load or not, to result in growth of internal strains and an accompanying decrease in density. However, commercial samples of tool steel, stainless steel, copper, and brass all show an increase of density under one-sided compressive deformation. On the other hand, soapstone, marble, and cast iron, subjected to similar stressing, flow very little but decrease in density. Complexities associated with internal flaws or cavities apparently are of dominating importance in measurements of this type.

Exploration of various stress laws for plastic flow and fracture supplies continuity and background motive for most of the author's experiments. The serious limitations of these laws are analyzed and discussed. As necessary supplements or replacements, the author draws attention to energy considerations, creep, inhomogeneous and nonisotropic strain hardening, and localized distortions resulting from flaws or corners. Thus he provides a wide variety of measurements that can be employed to check theoretical relations, shows that existing relations do not serve well for representation of his data, and suggests numerous plausible viewpoints which deserve trial in future explanatory efforts of workers in this field.

George R. Irwin

Mechanics Division, Naval Research Laboratory
Washington, D. C.

The Algebra of Vectors and Matrices. Thomas L. Wade. Cambridge, Mass.: Addison-Wesley, 1951. 189 pp. $4.50.

This book gives a lucid elementary exposition of the algebra of vectors and matrices, set in a framework of modern algebra. The opening chapter explains and illustrates the basic concepts of groups, integral domains, fields, and rings. Vectors and vector spaces are dealt with in the next three chapters. The vector products are defined in space of three dimensions, but examples of their utility are rather meager and could well be expanded. The linear dependence of vectors receives adequate treatment, first in three, then in n-dimensional vector space.

The remainder of the book is concerned with matrices. The treatment is simple and straightforward, and the theorems are all well illustrated with examples. The prerequisite mathematical background is only a course in analytic geometry and a knowledge of the usual theorems on determinants given in college algebra. The more advanced parts of matrix theory, such as the minimum equation of a matrix, are sensibly omitted, but references to more complete texts are always given. Among the topics dealt with in some detail are the characteristic equation, roots and vectors of a matrix, the Hamilton-Cayley theorem, elementary transformations, reduction of a matrix to the diagonal form, and the solution of sys-

tems of linear equations. A whole chapter is devoted to theorems dealing with the concept of rank and various theorems on linear dependence. Finally, the theory of matrices is applied to the study of bilinear and quadratic forms and their reduction to canonical forms.

On account of the importance and elementary character of the proofs, it is a matter of surprise that the author has omitted two basic theorems on symmetric matrices—namely, that their characteristic roots are real and that the characteristic vectors corresponding to distinct roots are orthogonal. In fact, the theorem on the reality of the roots is not even explicitly mentioned, although in dealing with the reduction of symmetric matrices it is tacitly assumed. But, on the whole, the author has shown excellent judgment as to the inclusion or exclusion of material for an admittedly elementary book—a book that should prove a most welcome introduction to a branch of algebra with manifold important applications.

LOUIS BRAND
Department of Mathematics, University of Cincinnati

Linear Transformations in n-Dimensional Vector Space: An Introduction to the Theory of Hilbert Space. H. L. Hamburger and M. E. Grimshaw. New York: Cambridge Univ. Press, 1951. 195 pp. $4.50.

In the introduction to his book *The Theory of Groups and Quantum Mechanics,* Hermann Weyl included the following comment:

> It is somewhat distressing that the theory of linear algebras must again and again be developed from the beginning, for the fundamental concepts of this branch of mathematics crop up everywhere in mathematics and physics, and a knowledge of them should be as widely disseminated as the elements of differential calculus.

That some progress toward this goal has been made in the more than 20 years since this was written is mainly due to the subsequent appearance of several fine treatises, elementary and advanced, dealing with this subject. The book by Hamburger and Grimshaw is a valuable addition to this steadily growing branch of mathematical literature. It introduces the ideas and methods of the theory of linear transformations in Hilbert space (the "operators" of quantum mechanics) by using them to present the more elementary theory in a finite dimensional space. Its principal results—the spectral representations of Hermitian transformations and the canonical representations and commutativity properties of general linear transformations—are developed in great detail. No use is made of determinants since there would be no analogous treatment in Hilbert space.

Neither the material nor its treatment is new. Nevertheless, even the specialist in this field will find novelty in some results and proofs, and in the organization of the material. Of special interest are the instructive notes, mostly historical and bibliographical, and the copious references. To the nonspecialist the book will not be easy reading. Although it is intended as an introduction to a more advanced theory, the authors pay little attention to didactical demands. Motivation of developments is brief or nonexistent, there is practically no illustrative material, no excursions to other fields, no signposts to guide us through the more complicated proofs. The authors state in the preface that they chose, for the greater part of the book, a concrete vector space in preference to an abstract space, so that the ideas may be more readily grasped. But not only does this choice necessitate duplication and circumlocution, but, by stressing the arithmetical against the geometrical aspect, it may actually produce the opposite effect.

Whatever objections one may have to these features of the book, its positive qualities are such that it deserves the widest use.

MICHAEL GOLOMB
Department of Mathematics, Purdue University

The Classical Theory of Fields. L. Landau and E. Lifshitz: trans. from the Russian by Morton Hamermesh. Cambridge, Mass.: Addison-Wesley, 1951. 354 pp. $7.50.

This book gives a systematic presentation of the theory of electromagnetic and gravitational fields. The entire treatment is relativistic. The first chapter covers the fundamentals of the special theory of relativity, that being the only part of relativity needed in the first two thirds of the book, which deal chiefly with the electromagnetic field. The second chapter treats relativistic mechanics. The last third of the book, devoted to the theory of the gravitational field, requires the general theory of relativity. Four-vectors and tensors and space vectors are used in the mathematical treatment.

Although physics is kept in the foreground, the treatment is deductive and mathematical. It is seldom that the authors refer to experiment except in general terms. All the fundamental laws of motion and field equations are derived from the principle of least action, with the integrand of the action integral S initially unknown. The form of the integrand of S in each case is inferred from a consideration of the kind of quantities that must appear in it, arguments concerning scalars and four-vectors or tensors, and similar general considerations. Sometimes these arguments appear not to be quite sufficient, and a little outside aid must be brought in. Nevertheless, the book goes far toward creating the impression that relativity theory and the principle of least action with the integrand of S initially unknown suffice to derive the fundamental laws. These derivations, however, are not quite complete deductive proofs in all cases. Thus, in getting the Lagrangian L for a free particle, a comparison is made with the L for Newtonian mechanics in order to determine a constant that turns out to be mc.

From arguments involving relativity the authors conclude that the electron and all elementary particles are geometrical points. They also state, however, that "electrodynamics as a logically closed phys-

ical theory presents internal contradictions when we go to sufficiently small distances." For the electron they obtain a distance $R_0 \sim e^2/mc^2$.

> This dimension [the "radius" of the electron] determines the limit of applicability of electrodynamics to the electron, and follows already from its fundamental principles. We must, however, keep in mind that, actually, consideration of quantum phenomena already set much higher limits than the limits of application of electrodynamics which have been presented here [so-called "classical limit"].

The treatment of general relativity is quite elegant. The physics is kept in the foreground rather than the geometry of space-time. The discussion of time, synchronization of clocks, and simultaneity in the general theory is thorough and excellent. The last part of the book deals with the application of general relativity to the universe as a whole.

For a reader with a background of knowledge of advanced Newtonian mechanics, this is an excellent and readable volume. It is a valuable and unique addition to the literature of theoretical physics.

ENOS E. WITMER

Department of Physics
University of Pennsylvania

Proceedings of a Second Symposium on Large-Scale Digital Calculating Machinery. Annals of the Computation Laboratory of Harvard University, Vol. XXVI. Harvard Univ. Press, 1951. 393 pp. $8.00.

Howard H. Aiken is to be congratulated on the appearance only two years later of this record of the second symposium held by the Navy Department Bureau of Ordnance and Harvard University at the Harvard Computation Laboratory in September 1949. The claim that the volume will function both as a progress report and as a preview of the future is more than borne out.

The field covered includes computing machinery both from the theoretical and from the practical standpoint; the analytical and numerical methods that are developing because large-scale machinery makes them practicable; and an account of the solution of various problems in physics, mechanics, and economics that has been made possible, as well as of proposals for solution of still larger problems.

In this field much information is in the air rather than in the literature. The reason for this seems to be that, although rapid advances are being made, many of the main ideas are not new, and no one likes to undertake the task of giving proper credit for them! Under these circumstances symposia such as this perform a large and valuable service in promoting exchange of information among the experts, as well as providing a means of disseminating it widely.

Besides a discussion by B. L. Moore, assistant director of the Harvard Computation Laboratory, of the Mark III machine, which was on view at the symposium, there are papers on the Bell Computer, Model VI, on Whirlwind, on the Raytheon machine, on a General Electric digital computer, on the 603–405 computer, and on Louis Couffignol's machine at Paris, as well as a paper on automatic computing machine development in England. In addition, there are several papers on machine components and on the general theory of machines, and a discussion of the future of computing machinery by Louis Ridenour.

The session on numerical methods is noteworthy as containing the paper on mathematical methods by D. H. Lehmer in which he gives his famous rule for producing pseudo-random numbers—that is, long series of numbers random enough for practical purposes. The papers on problems in physics, aeronautics and applied mechanics, and the economic and social sciences, seem to support the view that although aircraft dynamics has been the mainstay and mainspring of the machines, and offers a vast field of future work, their use for problems in physics has only just begun, and for problems in economics is almost entirely in the future.

Anyone interested in machine computing must read these papers.

L. H. THOMAS

Watson Scientific Computing Laboratory
Columbia University

Progress in Cosmic Ray Physics. J. G. Wilson, Ed. Amsterdam: North-Holland Pub.; New York: Interscience, 1952. 557 pp. $12.00.

Progress in Cosmic Ray Physics is a collection of eight survey articles by different authors on selected branches of cosmic ray study. The authors are among the foremost investigators in the fields they have surveyed, and a large portion of the work described is their own. This has an advantage over single authorship in assuring thoroughness of knowledge and accuracy of reporting on each topic. Furthermore, the task of writing the book is divided among numerous persons, and each chapter is more easily written because of the author's maximum familiarity with the subject. Only by such division of effort is it possible for men actively engaged in research to produce a book, and only by such means can the time of authorship be made small enough to permit publication before much of the material is obsolete. The present volume, issued early in 1952, represents the state of knowledge as of the early months of 1951.

The subjects covered, with the authors, are as follows:

> I, Properties of nuclear interactions revealed by analysis of stars seen in photographic emulsions, by Camerini, Lock, and Perkins; II, Masses and decay schemes of heavy mesons, by C. C. Butler—a survey, including numerous cloud chamber pictures, of evidence regarding the charged and neutral V-particles and the τ meson; III, The qualitative nature of the coupling properties of elementary particles as revealed by nuclear physics and cosmic ray experiments, by L. Michel; IV, The chemical composition, flux, and energy spectra of primary cosmic rays found by studies of emulsions exposed in balloons at high altitude, by B. Peters; V, The primary energy

spectrum and atmospheric absorption of cosmic rays, determined from counter and ion chamber measurements of the geomagnetic effects of cosmic rays at various altitudes, by H. V. Neher; VI, The intensities, genetic relations, and energy balance of the components of cosmic rays, by Puppi and Dallaporta; VII, The nature, intensity, and interactions of cosmic rays observed underground, by E. P. George; VIII, Observations and analysis of time variations of cosmic ray intensity, by H. Elliot.

Naturally, cosmic ray physics cannot be divided into branches that are independent of each other; the subjects listed above overlap considerably. Yet each chapter is self-contained. This adds to the clarity of individual sections, but, as a result, some topics are discussed more than once—for instance, the primary energy spectrum of cosmic rays appears in Chapters IV, V, and VI. The overlapping material is not even perfectly consistent in all cases. This reviewer finds such repetitions and differences in point of view helpful, and considers them to be one of the advantages of the multiple-author collection of articles over a perfectly coherent account by a single author.

The selected branches of cosmic ray study do not include the whole range of current investigation; limitations of space made it impractical to try to cover all the subjects of interest. Perhaps the most important topic left out is the study of extensive showers in the atmosphere. The same limitations of space have restricted the amount of data and discussion that could be presented in each chapter; and, particularly in the first chapter, on nuclear interactions of the cosmic rays, this restriction seems regrettable. The editor offers the hope, however, that a second volume will be forthcoming, in which topics thus far omitted will be discussed and developments since the date of preparation of the first volume can be added. It is doubtful, however, whether any book can keep pace quite satisfactorily with the physics of elementary particles, of which one or two new types have already been discovered since the present one was written.

KENNETH GREISEN
Department of Physics, Cornell University

The Design and Analysis of Experiments. Oscar Kempthorne. New York: Wiley; London: Chapman & Hall, 1952. 631 pp. $8.50.

The revolution in methods of designing experiments initiated by R. A. Fisher in *Statistical Methods* (1925) and *Design of Experiments* (1935) is presumably well known to readers of SCIENCE. Beginning with papers on "Complex Experiments" (1935) and "Design and Analysis of Factorial Experiments" (1937), by F. Yates, it launched much activity in exploration of combinatorial arrangements that would give designs suited to manifold purposes. The time is ripe for a stocktaking of what has been achieved. In 1950 Cochran and Cox' treatise covered the requirements of experimentalists, and H. B. Mann summarized the basic mathematics from a mathematician's point of view. But neither of these attempted to encompass the great amount of work that has been done on the level of mathematical statistics. Kempthorne now gives us a comprehensive account of the methods used to develop designs, and of computational procedures for analysis of results, in a book that maintains the high standard of the Wiley publications in statistics. It will be a pivotal landmark in development of the subject.

Par excellence, it is a book for experimental statisticians; they, however, will look to statistical journals for critical reviews. The potential value to others is difficult to assess.

The first 12 chapters (233 pages) are described in the preface as introductory. Although the methods described have been used in statistical laboratories for some years, no comprehensive account has previously been published. To many this will be the most valuable part of the book. Computational methods are described in detail from an elementary level. On the contrary, proofs are given in matrix notation, with no condescension to mathematical immaturity. As knowledge of matrices is rapidly becoming essential for understanding of much statistical literature, students will welcome having a presentation of least squares theory in this form. Some sections, however, seem rather more clumsy than they need be; with very little extension the path might have been made easier for students just learning these methods. The last section, in particular, seems to have been made unnecessarily difficult by ill-defined shifts of notation.

A discussion of randomization tests and the "finite model" will be novel and illuminating to many students. Divergent points of view, which have been topics of severe controversy, are drawn skillfully together.

Chapters 13–20 run parallel to Cochran and Cox' book, but at a more mathematical level and with little actual duplication. They cover factorial experiments, incomplete blocks, and, finally, two chapters on groups of experiments and treatments in sequence.

Exponents of complex designs have used mathematical tricks and specialized notations that are tremendously helpful once they have been mastered, but that make much of the literature obscure to the uninitiated. Readers new to the subject will find these fully explained. Only very occasionally are extensions indicated without adequate explanation (e.g., the $3^2\ 2^2$ design on p. 363 appears incomprehensible). Exposition is generally clear and free from ambiguity. An important feature is that practical aspects are always kept in view. Frequent warnings are interspersed against uncritical use of elaborations, with risk of the empirical model departing too far from reality, or of losing sight of the main objectives in a maze of intricacies, which may have the fascination of a chess problem but do not produce most profitable experimentation. The more complex arrangements are introduced with the healthy remark: "The advantages which accrue from using the simpler types of experi-

ment will become evident from the descriptions that follow."

For a first edition, breaking new ground, a high level of accuracy has been maintained. Inevitably, one could make criticisms of detail—object to an example, to confusion of notation, and so on—but this is not the place to argue these. This is an important book. All who want to master its subject matter will be grateful for its thorough exposition and the drawing together of so much material between two covers.

H. Fairfield Smith
Department of Experimental Statistics
North Carolina State College

Chemistry and Biochemistry

Physical Properties and Analysis of Heavy Water. Isidor Kirshenbaum. Harold C. Urey and George M. Murphy, Eds. New York–London: McGraw-Hill, 1951. 438 pp. $5.25.

This book by Kirshenbaum, with Urey and Murphy as editors, constitutes a valuable addition to the National Nuclear Energy Series.

The first chapter gives a number of useful tables listing all the known physical properties of D_2O. In the second chapter one finds a discussion and description of the theory and experimental data for isotopic exchange equilibrium constants; in particular, there is included considerable information for deuterium exchange in the hydrogen ammonia system, that has never before been published. The next 300 pages contain detailed descriptions and directions for hydrogen-deuterium analysis, as well as for the isotopic analysis of oxygen by a number of different methods. Of these, approximately 200 pages are devoted to the mass spectrometer, and about 100 more to the methods involving the measurement of the density of water. Both the mass spectrometer and the density methods are described in great detail, so that the book contains a wealth of experimental observations and recommendations concerning techniques. Nowhere else can such a body of useful information be found.

The author draws freely on many unpublished Manhattan Project reports, so that one can find for the first time details of much of the secret work done during the war. In fact, this reviewer learned the disposition and utilization of some apparatus constructed for the Manhattan Project at Northwestern University in 1942; aside from the fact that the apparatus had been taken to and installed in the laboratory at Trail, B. C., we never knew whether any practical use had been made of it. The last chapter of the book contains a good review of present knowledge concerning the natural abundance of hydrogen and oxygen isotopes.

As Kirshenbaum himself did much of the work discussed in the book, he was amply qualified to write of it in an authoritative manner. With Urey and Murphy as coeditors one can feel sure that no important methods have been omitted and that the opinions expressed are entirely sound. The author and the editors are to be congratulated on an excellent and useful job well done.

Malcolm Dole
Department of Chemistry, Northwestern University

Light Hydrocarbon Analysis. Analytical methods compiled and tested for the Office of Rubber Reserve, Reconstruction Finance Corporation, by the Butadiene Committee on Specifications and Methods of Analyses. O. W. Burke, Jr., C. E. Starr, Jr., and F. D. Tuemmler, Eds. New York: Reinhold, 1951. 639 pp. $15.00.

The foreword, by E. R. Weidlein, states ". . . this presentation constitutes a valuable contribution to scientific knowledge." The preface states that the Committee on Butadiene Specifications and Methods of Analyses is completing its war emergency assignment with the publication of this book. The titles of the 9 chapters are: "History and Function of the Committee on Butadiene Specifications and Methods of Analyses," "Butadiene Production Processes," "Butadiene Specifications and Applicable Test Methods," "Schemes of Analysis," "Sampling and Handling of Light Hydrocarbons," "Safety Precautions for Handling Light Hydrocarbons," "Analytical Methods," "Preparation of Samples of Known Composition for Test Programs," and "Evaluation of Accuracy and Precision of Methods." In addition to numerous informative tables, photographs, and drawings, there are 114 appendix tables (one to a page, mostly in fine print) which present analytical data on various test samples. These data are both chemical and physical, including distillation, spectral, and data from combination methods.

Abbreviations used are seldom defined, although the meaning of RFC and the letters designating the various government rubbers is given in pages 1–3. Probably a good many foreign, and at least some American, readers might like to know what ORR, O.R.R., L.H., L.M., psia, DD, etc., stand for.

The 54 procedures as set forth in Chapter 7 (363 pp.) have "L.H." numbers. (The abbreviation "L.H." presumably, is for "light hydrocarbons" and facilitates cross-referencing.)

The three-page index is totally inadequate for a work of this magnitude. For example, it fails to list diamylamine, an important component in the reagent for 1,3-butadiene (p. 163). A few of the tables, such as Table 76, are scarcely legible. Methods are referred to without stating what they are—e.g., the gravimetric method (p. 467) for 1,3-butadiene (L.H. 510, p. 27). The book contains about 70 references to the scientific literature. Many more would be useful.

This book will be of interest to the large number of investigators who were, or still are, connected with butadiene analysis. It contains a large amount of miscellaneous information (only part of it still useful) under a misleading title. A more appropriate

title would be, "Light Hydrocarbon Analysis Pertaining to Government Synthetic Rubber." In spite of its high price, the book probably should be purchased by technical libraries because of the procedures given that are not available elsewhere.

DAVID CRAIG
B. F. Goodrich Research Center, Brecksville, Ohio

Agricultural Chemistry: Practical Applications of Agricultural Chemistry, Vol. II. Donald E. H. Frear, Ed. New York: Van Nostrand, 1951. 588 pp. $9.50.

Agricultural chemistry means different things to different people. However, no matter what may be the definition most favored by a reader, he is likely to find in this volume material that will interest and inform him with respect to the chemistry of agricultural products and processes. In preparing the 24 chapters of this book, Dr. Frear was aided by 22 authors, each a specialist in his own field. Dr. Frear himself prepared chapters on insecticides, fungicides, and herbicides.

The book is divided into four major parts dealing, respectively, with the chemistry of major agricultural products, the chemistry of fertilizers and soil amendments, nutrition of farm animals, chemistry of pesticides, and a final, relatively brief, fifth part discussing patent law and practice and the chemurgic utilization of some agricultural products.

A good deal of material is presented in useful tabular form (122 tables and 45 figures). Relevant summary tables of composition, properties, production, nutrient allowances, utilization, etc., are included —a desirable feature in a reference book of this type.

The level of treatment is perhaps a little uneven but in general calls for something more than an elementary knowledge of chemistry. In the preface it is indicated that the book is intended to be "a general reference text on agricultural chemistry" for advanced students, specialists, and research investigators. As such, it appears to be a good, workmanlike job.

A. G. NORMAN
Chemical Corps, Camp Detrick
Frederick, Maryland

Biological Antagonism: The Theory of Biological Relativity. Gustav J. Martin. Philadelphia–Toronto: Blakiston, 1951. 516 pp. $8.50.

This monograph is a comprehensive review and evaluation of studies related to the general phenomenon of biological antagonism. It should be of value to all investigators in the fields of biological science, for, as the author clearly brings out, biological antagonism is a basic aspect of all biological systems. The first chapter considers the specificity and kinetics of enzyme action and of enzyme inhibition. This is followed by 20 chapters on antagonists of the amino acids, vitamins, purines, pyrimidines, steroids, inorganic ions, etc. Although the treatment is extensive and detailed, these chapters were written with the needs of both the specialized and the general reader in mind. There is an outline at the beginning of each chapter and a liberal use of bold-face type, formulas, and summary tables. Each chapter is concluded with a recapitulation of the material—a valuable feature that should be more common in works of this type—and an adequate bibliography.

Dr. Martin, in order to present the scope and implications of biological antagonism in relation to enzyme systems, emphasizes the relative specificity of enzymes with respect to closely related compounds rather than the limitations of activity resulting from gross differences in substrate structure. This viewpoint, which is used in the discussions and interpretations throughout the volume, is evolved, in the final chapter, into a theory of biological relativity.

According to the author

> . . . the study of biological antagonism leads to the conclusion that there are no absolutes in biological systems which distinguish them from physical systems. . . . In any event, every phase of biology is relative; there are no absolutes beyond time. Enzymatic activity possesses only relative specificity. There are invariably several structural units possessing the power of functioning as a vitamin. No ion has been demonstrated to possess absolute specificity. Every phase of biological systems is relative. There can be no absolutes from the structural standpoint. The theory of biological relativity states that no single molecular structure possesses a function not shared in some degree by structurally related molecules.
>
> Another concept evoked by study of biological antagonism is that biological order is actually based upon disorder, upon antagonism. As with physical laws which are statistical, so biological systems represent the end results of chance. The orderly characteristics are in reality due to biological antagonism, to competing molecular units.

The author and publishers of this volume have made a valuable contribution to the literature of biological science.

C. R. TREADWELL
Department of Biochemistry
George Washington University School of Medicine

The Enzymes: Chemistry and Mechanism of Action, Vol. II, Part 1. James B. Sumner and Karl Myrbäck, Eds. New York: Academic Press, 1951. 790 pp. $14.80.

This volume is the third in a series of four designed to cover the major topics in enzyme chemistry. It has the most coherent organization of the series; the contributions with only a few exceptions deal with biological oxidations. Since the contributors are well-known authorities on the subjects they present, this volume, like the previous ones, is of a high caliber. The articles for the most part lack detailed information about methods. Considering how thoroughly dependent the progress, and even the language, of enzymology have been on the development of its methods, even a partial neglect of this aspect of the subject represents a serious limitation. These volumes thus do not replace the *Methoden der Fermentforschung* and an up-to-date version of the latter work is still very much needed.

The opening chapter on the theory of oxidation-reduction by the late L. Michaelis contains interesting comments on the mechanism of enzymatic oxidations. The critical importance of phosphate in the processes allied to biological oxidations is covered in three chapters. N. O. Kaplan classifies the various types of phosphate bonds, their biological generation and utilization, and calculation of their energy content. S. P. Colowick presents a much-needed lucid discussion of transphosphorylating enzymes and H. M. Kalckar summarizes information on the dephosphorylation of adenosine polyphosphates. A comprehensive review of the pyridine nucleotides and their apodehydrogenases is written by F. Schlenk. The general properties of flavoproteins and a treatment of the known flavin enzymes are covered by H. Theorell. Discussion of the iron-containing enzymes is divided among sections on the cytochromes by K.-G. Paul, the catalases and peroxidases by H. Theorell, and the nature of enzyme-substrate interaction by B. Chance. Copper oxidases are reviewed by C. R. Dawson and W. B. Tarpley.

There are chapters on amino acid oxidases by H. A. Krebs, amine oxidase by E. A. Zeller, lipoxidases by R. T. Holman and S. Bergström, and organic sulfur oxidases by C. Fromageot. Anaerobic glycolysis, which still holds many secrets, is reviewed by F. Dickens, and the subject of yeast and mold ferments is thoroughly reviewed by F. F. Nord and S. Weiss. Chapters are also included on aldolase and isomerase by Meyerhof, on keto acid decarboxylases by B. Vennesland, amino acid decarboxylases by O. Schales, desulfinase by Fromageot, succinic dehydrogenase by F. Schlenk, hydrogenase and hydrogenlyase by W. W. Umbreit, and the enzymes in luminescence by E. N. Harvey.

ARTHUR KORNBERG

National Institute of Arthritis and Metabolic Diseases
National Institutes of Health

Aspects of the Constitution of Mineral Oils. K. Van Nes and H. A. Van Westen. Houston-Amsterdam: Elsevier Press, 1951. 484 pp. $9.00.

This is a most important book for all who are interested in the chemistry of petroleum oils. The authors are members of the research staff of the Koninklijke/Shell-Laboratory in Amsterdam, and they acknowledge supervision of the work by J. J. Leendertse. As stated in the preface, "The primary object . . . was to introduce a hitherto unpublished method for structural group analysis." The book also includes a fairly comprehensive survey of our present knowledge concerning the constitution of mineral oils, more especially the lubricating oil fractions. "The new method referred to can be considered as a thorough revision of the 'ring analysis' or 'Waterman analysis.' It is based on the same principles but has a sounder experimental background and is of simpler application."

The essential thesis of the present work could have been presented as a monograph of about 200 pages, but the authors have naturally included much well-reviewed material on the physical properties of hydrocarbons, methods of separation, characterization, and identification that serve as background to make the purpose and value of their own contributions clearer.

It is of especial interest to the reviewer that the authors have included an excellent chapter of 51 pages, including a bibliography of 101 references, on the genesis of mineral oils. However, they have been unable to find, in any of the references cited, any clue to the formation of the complex polycyclic hydrocarbons in which they are primarily interested, nor do they speculate as to how such complex hydrocarbons have been formed. They seem to favor the catalytic action of silicates. "For lack of a better explanation of the numerous reactions that must have taken place . . . it seems best for the present to adhere to the hypothesis of low-temperature catalytic cracking."

The "ring analysis" method as developed by Vlugter, Waterman, and Van Westen was first published in 1932. This method involved hydrogenation of the oil fractions and determination of physical properties before and after hydrogenation. Since 1932 a great deal of work has been done. The data required by the method evolved by the authors include only the refractive index (n), density (d), and the molecular weight (M)—hence it is referred to as the n-d-M method. It is doubtful if this method could be published in any of our scientific journals with anything approaching the thoroughness of the present volume. It seems likely that more and more original work will be published in the form of monographs.

BENJAMIN T. BROOKS

405 Lexington Avenue, New York

The Biological Sciences

Genetics and the Origin of Species. 3rd ed. Theodosius Dobzhansky. New York: Columbia Univ. Press, 1951. 364 pp. $5.00.

That a third edition of this book is required in less than 15 years is convincing evidence of its importance as an argument of the genetic mechanisms of evolutionary change, and even more of its lucidity and readability. The first edition, published in 1937, won immediate recognition as the most competent analysis of the origin of species since Darwin. Like Darwin's work, it contained no new facts but it marshaled the available genetic data and, in terms of the principles of population analysis developed by Sewall Wright, made their evolutionary implications unmistakable. The second edition, which appeared four years later, was considerably larger and gave a much more extensive review of relevant genetic studies in plants as well as in animals. In 1941, recognition of the scientific merit of the second edition received public acknowledgment in the award to the author of the

Daniel Giraurd Elliot Medal of the National Academy of Sciences and a certificate for the most meritorious work in zoology and paleontology of the year.

Like the preceding editions, the new one preserves the original framework in the same chapter headings, but it is completely rewritten and includes some discussion of most of the relevant studies of changing populations that have appeared in the past 10 years. Unlike the second edition, the present work has been deliberately shortened—particularly by eliminating discussion of many of the recent plant studies, expanded accounts of which are given in *Variation and Evolution in Plants* (SCIENCE, **112**, 764 [1950]), by G. L. Stebbins. The literature list has been expanded to include the large number of important titles of the past 10 years.

What this book is about is adequately stated in the preface:

> . . . instead of the varied theories of evolution which arose in different branches of biology, we are now witnessing the emergence of a new science of life unified by the great evolutionary idea. . . . Biology is becoming more than a branch of technology concerned with organic materials and processes. It aspires toward . . . an understanding . . . of the organism as a part of the constantly changing and developing pattern of nature. Evolutionary biology is a study of the dynamics of life.

In the increasing understanding of this unfolding pattern the experimental studies of the author himself have had an important part. These studies in experimental evolution in wild populations of *Drosophila pseudoobscura*, published for the most part since the last edition of his book under the general title "Genetics of Natural Populations," are summarized briefly in the present volume. The basic fact that emerges from the genetical study of evolutionary change is that the population is the essential unit and not the individual.

The chapter headings indicate the general argument of the book: organic diversity, heredity and mutation, selection, adaptive polymorphism, race formation, isolating mechanisms, hybrid sterility, species as natural units, and patterns of evolution. The key chapter, and certainly the longest, is that devoted to isolating mechanisms. "Race and species formation without isolation is impossible." "Species may be maintained distinct by any, or a combination of several, reproductive isolating mechanisms." The most direct evidence in support of the whole thesis is given in the chapter on hybrid sterility. Here it is shown by well-tested examples that there are a great many effective natural mechanisms for reproductively isolating varieties and species. Thus "the species is not a static unit, but a stage in the process of evolutionary divergence." Again, "species are groups of populations, the gene exchange between which is limited or prevented in nature by one, or a combination of several, reproductive isolating mechanisms. In short a species is the most inclusive Mendelian population."

The final chapter, on patterns of evolution, summarizes the whole argument.

> The biological function of sexual reproduction is the formation of an immense variety of genotypes, some of which prove to be adaptively valuable and are established by natural selection. Conversely, reproductive isolation prevents the gene exchange between populations which occupy different adaptive peaks. [There are some human applications that may find less ready acceptance.] Genetically conditioned educability favors diversity of human personalities and cultures. . . . The biological meaning of the diversity among humans, like that of organic diversity on the biological level, is adaptation to the variety of environments which the organism encounters or creates.

This book has become the twentieth-century equivalent of Darwin's *Origin of Species*. As such it can be read with profit by biologist and layman alike.

H. H. PLOUGH
Department of Biology, Amherst College

Checklist of Palaearctic and Indian Mammals, 1758 to 1946. J. R. Ellerman and T. C. S. Morrison-Scott. London: British Museum (Natural History), 1951. 810 pp. £3 5s.

This is a major work, of great and obvious importance to students of mammals and likely, through them, to have future significance for the whole subject of systematics.

No modern list of the mammals of the largest land mass on earth has been available. In itself, the provision of such a list is a great contribution, but the authors have done much more than that. Designation of this work as a "checklist" is a British understatement. This big, handsome volume is, in fact, a complete systematic revision of all the 809 species and still more numerous subspecies of an enormous fauna. The revision is based not only on the literature but also on firsthand study of the collections of the British Museum, unrivaled in richness for most of the region involved.

For each major and, as needed, many minor groups, there is a brief, adequate discussion of the reasons for the present arrangement. Synonymy is given for all genera, species, and subspecies, and geographic ranges for species and subspecies. References are given not only to original publications of descriptions of all genera and smaller groups, but also to diagnostic reviews for genera and species. Where such reviews are not available, the authors have provided new morphological keys. In spite of the fact that there are no illustrations or formal descriptions, this work thus facilitates identification of any mammal from its region.

This is not the place for discussion of differences of opinion as to the formal classification. It is in general highly satisfactory, and deviations from previous arrangements are explained. Some of these deviations are not likely to be generally accepted, but on the whole they point forward to improvements in the classification of the order.

The broader significance of the work is its bearing on trends in the systematics of living organisms in general. Mammalogy is now reaching a point at which

ornithology arrived some time ago and toward which other branches of systematic zoology are tending—the end of the age of discovery. Certainly very few living mammals remain to be discovered. The discovery of any *really* new genus (one of which no species was known before) is improbable, and few really new species are likely to turn up. As this point approaches, there is a tendency for systematists grossly to exaggerate the differences among known forms. Later there develops a more mature systematics, less concerned with giving new names than with elucidating the biological relationships of populations.

Ornithology is happily well advanced in its mature phase. Mammalogy is not, but this book is one of the signs that the phase has begun. At least, it displays a substitution of rational synthesis for excessive, ill-grounded analysis. As a rather extreme but significant example, the authors recognize (for their area) 14 species of the genus *Felis*. At one time or another these have been placed in 101 species (of which 42 are now considered valid as *subspecies*) and under 35 generic names (9 now used for *subgenera*). To be sure, this is only a beginning, for the authors' approach is morphological and full biological significance does not automatically emerge. It is, however, a great stride toward getting the morphological data into a form that *does* have biological meaning.

G. G. Simpson

Department of Paleontology and Geology
American Museum of Natural History, New York

Traité de Zoologie: Anatomie, Systématique, Biologie — Insectes Supérieurs et Hémiptéroïdes, Vol. X, Parts 1 and 2. Pierre-P. Grassé, Ed. Paris: Masson, 1951. Part 1, 975 pp., 6500 fr.; Part 2, 973 pp., 6500 fr.

For generations European zoologists have, at intervals, undertaken many-volume encyclopedic works on their science. These studies are of a character quite different from anything ever produced in America. They serve the important purpose of collecting a vast quantity of information in a single series of volumes, so that biologists can readily obtain at least some information on virtually any animal group. A disadvantage of a compilation such as this is that unless authorship is split to an impossible degree, not every section can be written by a specialist. It seems likely that every entomologist will find the work reviewed here full of interesting information of which he was previously unaware. On the other hand, when he reads the sections on the particular groups of insects in which he specializes—and occasionally elsewhere in the book—he will be disappointed because of basic errors or unfortunate omissions.

Volume X of *Traité de Zoologie* is so large that it is bound in two fascicles, having the consistently fine appearance and, for the most part, excellent illustrations of this series. The following is a list of the insect orders treated in the volume, with the authors and the number of pages in parenthesis: Neuroptera (L. Berland, P. Grassé, 64); Mecoptera (P. Grassé, 54); Trichoptera (R. Despax, 49); Lepidoptera (J. Bourgogne, 275); Diptera (E. Séguy, 295); Siphonaptera (E. Séguy, 25); Hymenoptera (L. Berland, F. Bernard, 506); Strepsiptera (R. Jeannel, 23); Psocoptera (A. Badonnel, 40); Mallophaga (E. Séguy, 24); Anoplura (E. Séguy, 20); Homoptera (P. Pesson, 267); Heteroptera (R. Poisson, 147); Thysanoptera (P. Pesson, 64).

After a brief definition of each order, an extended and well-illustrated treatment of the external and internal morphology of adult, larva, and pupa is presented. These morphological sections present a vast amount of interesting detail on structures and functions. Unfortunately, no serious effort has been made to use a single morphological nomenclature consistently throughout the work, so that homologous structures may go under different names in different orders of insects.

Following the morphological section for each order are usually found sections on bionomics, ecology, distribution, and sometimes physiological or genetic details relating to the order. A section on systematics gives information on each family, usually with a brief characterization (no keys) and a statement of habits and distribution, often also mentioning certain species of biological interest or of medical or agricultural importance. The systematic sections are illustrated by many figures, a list of which would be found to be particularly rich in the unfamiliar or bizarre types (e.g., the thrips—such as Nymphomyiidae, Diptera). The classification followed is not extreme, although in some sections (e.g., ants, sphecoid wasps, leaf hoppers) more families are recognized than seem necessary or desirable. At the end of the treatment of each order is a bibliography containing references to some of the more important works on the group.

It is perhaps worth mentioning that the section on Mecoptera seems particularly full and well done, and that it contains a review of Tillyard's work on the "panorpoid complex."

Charles D. Michener

Department of Entomology, University of Kansas

The Genetics of Micro-Organisms. D. G. Catcheside. New York–London: Pitman, 1951. 223 pp. $4.50.

The introduction of genetic methods to studies of biochemistry and microbiology has created a need for just this sort of book. It

> . . . is based on a course of lectures devised for biochemists specializing in the microbial aspects of their subject. It attempts to provide an introduction to the general and special aspects of the genetics of micro-organisms.

Students of genetics will also find the book of great value, since it brings together a great deal of material which is strongly influencing current genetic thought and which is not covered in most textbooks of genetics. The book is well written, compact, and "meaty"—but the full appreciation of certain genetic implications

may require some previous knowledge of genetics.

Approximately half the book deals with the genetics of fungi, largely of *Neurospora*. Separate chapters are devoted to the genetics of yeasts, protozoa, bacteria, and viruses. This arrangement means that certain subjects—such as mutation, adaptation, cytoplasmic inheritance, etc.—are split up to a certain extent, but this is perhaps necessary, since reproductive systems are so dissimilar in different groups of organisms that it might be confusing to consider them together. There is a chapter on the sexual reproductive systems of fungi and algae which illustrates the diversity of hereditary mechanisms present in these groups, and which should be very useful as a basis for selecting the material best suited to particular studies.

Although the text was completed in February 1949, it is surprisingly up to date and complete. Pertinent literature to the end of 1949 has been reviewed, apparently by additions to the proof. Important studies are discussed in some detail, and the methods used and inferences drawn are critically reviewed. There is a good bibliography that cites recent reviews, when available, rather than earlier, individual publications. Literature references in the text are by superscripts indicating items in a single bibliography. This simplifies the reading for those not particularly interested in the authors concerned.

This reviewer considers that the book has been well planned and successfully written. There are remarkably few errors either by the printer or by the author. The treatment of the material may not be as elementary as the preface implies.

STERLING EMERSON*

Division of Biology
California Institute of Technology

* Currently visiting professor at the Botany School, University of Cambridge.

Embryology of the Viviparous Insects. Harold R. Hagan. New York: Ronald Press, 1951. 472 pp. $6.50.

When a person engaged in teaching and research for many years undertakes to summarize his work and put it between the covers of a book, an important and worth-while contribution usually results, and fellow-workers in the field derive great benefit. Such a book is *Embryology of the Viviparous Insects.*

As the author says in his preface, this book

> . . . has been designed to fulfill three functions: as a text for the student entomologist, as a source book for the professional entomologist or general zoologist, and as a reference tool for public health and applied research workers who desire a knowledge of the embryogenies of viviparous hexapods.

The book is divided into two parts, entitled "General Considerations" and "Embryogenies." In the first part, terms are defined and concepts explained—preliminaries that are so necessary in a highly specialized work. Then the anatomy of the female reproductive organs is described, followed by an explanation of general embryological sequence, organology in the older embryo, and a general classification of types of viviparity. Hagan gives here his classifications based on his own research and discusses at length his reasons for such classification.

Part Two consists of embryogenies of individual insects, ranging from more simple ovoviviparous types up to the highly specialized pseudoplacental forms, such as various aphids and the Polyctenidae. This section ends with Chapter 15, an appraisal of viviparity. In some respects this is the most interesting chapter of all—although generalizations such as these are of course highly speculative, and at times a tinge of Lamarckianism creeps in. There is probably more of the author revealed here, however, than in any other part of the book.

One must examine this book in light of the functions that the author says it must fulfill. As a text the book is invaluable. It sheds light on a difficult field of study. It makes clear some of the most puzzling problems of development and, through his classification, so ably explained, brings order to these problems. As a reference work for the professional entomologist or the general zoologist, it will fill a long-felt vacancy. And the research worker in public health will be greatly aided by the well-drawn-up embryogenies. One regrets only that more illustrations were not included. The development of *Chrysomela varians*, although described in detail, is illustrated by only four diagrammatic cross sections. The development of *Glossina* in the section on adenotrophic Diptera would benefit with more complete illustration. For those unfamiliar with the intricate development of insect embryos more illustrations to accompany the descriptive material would aid greatly in understanding. Despite this criticism, the volume ably fulfills the three functions stated in the preface and will be a valuable addition to any entomologist's library.

The bibliography is excellent and complete. The book is well worth close study by those interested in fundamental entomology, and one must congratulate Professor Hagan for his achievement in summing up the work of a lifetime in the difficult field he has chosen for his research interest.

F. H. BUTT

Department of Entomology, Cornell University

The Origin, Variation, Immunity and Breeding of Cultivated Plants. N. I. Vavilov; trans. from the Russian by K. Starr Chester. Waltham, Mass.: Chronica Botanica; New York: Stechert-Hafner, 1951. 364 pp. $7.50.

N. I. Vavilov, who championed classical genetics in the dramatic and tragic controversy with T. D. Lysenko, exponent of a biology molded to current Russian ideology, lost not only his courageous battle for freedom of inquiry but also his life. But his works, like those of earlier martyrs of science, may well endure long after his adversaries and their strange dogmas are forgotten.

This volume presents English translations of Vavilov's contributions to a symposium on "The Scientific Basis for Plant Breeding," of which he was the editor and principal contributor. It includes, in addition to an introductory essay and an extensive bibliography, four articles of which the first, "Phytogeographic Basis of Plant Breeding," is perhaps the most important. Here we have Vavilov's final conclusions on centers of origin of cultivated plants after a lifetime of exploration and study. Here is the first comprehensive and authoritative work on the origin of cultivated plants since de Candolle.

As a result of his extensive studies on cultivated plants and their relatives in all parts of the world, Vavilov recognized eight principal centers of origin: China, India, Indo-Malaya, Central Asia, the Near East, Abyssinia, the Mediterranean region, Middle and South America. Each of these regions possessed natural floras containing species amenable to domestication and each has made important contributions to the world's useful plants. Contemporary students of cultivated plants may differ with Vavilov on details (this reviewer differs with some of his conclusions on maize), but they can scarcely fail to recognize the monumental contribution he has made by clarifying the picture of the origin of cultivated plants and the geographic distribution of their wild relatives.

The other three articles in this volume, although useful, are by no means as significant or of such general interest as the first. One article is devoted to parallel variations in related species and is an elaboration of Vavilov's earlier work on this subject. Another, on immunity to diseases in plants, is of primary interest to pathologists and plant breeders. The final paper, entitled "Scientific Bases of Wheat Breeding," is a comprehensive monograph on this important cereal and contains much invaluable information for botanists and plant breeders alike. The new species of wheat that Vavilov and his colleagues have discovered are already being used for breeding purposes in America and other countries. His conclusions on the origin of the several cultivated species will be of great interest to archaeologists and anthropologists.

Dr. Chester's translation of the articles is excellent. Dr. Verdoorn, Chronica Botanica editor, has rendered an important public service in making these somewhat inaccessible works available to English-speaking scientists who, still enjoying freedom of inquiry, can use them in the improvement of cultivated plants and in the advancement of knowledge in several fields.

PAUL C. MANGELSDORF

Department of Biology, Harvard University

Mineral Nutrition of Plants. Emil Truog, Ed. Madison: Univ. Wisconsin Press, 1951. 469 pp. $6.00.

This volume is the result of the symposium on the mineral nutrition of plants held at the University of Wisconsin in 1950. In its 18 chapters existing information, both theoretical and practical, on the mineral nutrition of plants is presented by leaders in their particular fields. Nowhere on the cover or title pages, however, is there any indication that the book is a symposium rather than a monograph or textbook. This will be a disappointment to those who, from the title, will expect to find a well-rounded treatise of mineral nutrition. In addition, the great variation in the technical and readability levels of the different papers is an undesirable feature—although one that is characteristic of symposia. On the other hand, for those who wish to obtain the latest views on several of the many phases of mineral nutrition, this volume will be useful. It might better have been titled "Advances in the Mineral Nutrition of Plants."

After an introductory chapter on the fertility of the great soil groups and world fertility problems, the remaining 17 chapters are divided into five sections, with an attempt to provide a logical sequence starting with the soil and ending with environmental influences on the growth and nutrition of plants. Several gaps were left, especially on the correlation of soil types and geographic regions with mineral deficiencies, and the effect of mineral deficiency on plant morphology and nutritive value.

In the first group of chapters, which deals with soils, an excellent review is given on the manner whereby the soil functions in the gradual allotment of its nutrient elements. This is followed by several chapters in which existing views on ionic movement of nutrients are discussed, together with the complexities involved. The section closes with chapters on the effect of the physical properties of the soil and the role of microorganisms as each affects nutrient availability. The second group of papers deals with the mechanism of ion absorption by the plant and the translocation of nutrients within the plant. The latter phase is illustrated by several excellent autoradiographs.

Two specific field problems are considered in the third section. One takes up the control of nitrogen effects on apple trees and the other, nutritional field problems in the production of vegetables for the canning industry. In the fourth section are three pertinent papers on the role of minerals in plant nutrition. The first considers the criteria by which the essential nature of inorganic nutrients are determined; another discusses mineral nutrition in relation to the ontogeny of plants; in the third, the correlation between protein-carbohydrate metabolism and mineral deficiency in plants is outlined. The material in this section succeeds unusually well in presenting difficult subject matter clearly and concisely. In the last section are three papers dealing with modifying influences of various environmental factors, including light and moisture, upon mineral nutrition.

The up-to-date information provided by the contributors to this book, all of whom are actively engaged in research, will be of special interest and value to many teachers and investigators, as well as to others concerned with the practical applications.

FRANK A. GILBERT

Battelle Memorial Institute, Columbus, Ohio

The Principles of General Biology. Mary S. Gardiner. New York: Macmillan, 1952. 657 pp. $5.75.

This book impresses the writer as being one of the better general biology texts to appear in the postwar era. Dr. Gardiner has made a wide and general survey of the field of biology, stressing basic concepts, rather than presenting a collection of facts. Unlike so many of the more recent books, which lay great emphasis on man, this book deals with the more general and fundamental concepts of biology. To this reviewer, this seems to be one of the book's most desirable features. The author definitely states that the book is not designed as a day-by-day text, but is intended as a supplement to classroom and laboratory work.

The book is divided into four sections. The first part, "The Organization of the Natural World," is particularly well done. It deals with the cell, protoplasm, and the physicochemical aspects of biology. It is clearly written and can be followed by students with limited training in the fields of physics and chemistry.

A rather unique feature of the section "The Organization of Biological Systems" is the comparative treatment given the organization of living things. For example, plants (Thallophyta) and animals (Protozoa) at the lower levels of organization have been discussed together. The same comparative treatment is given the Metaphyta and Metazoa. This type of comparative treatment seems to have definite advantages in emphasizing the unity of living organisms. This is followed by a rather detailed serial consideration of the Annelida, Arthropoda, and Chordata. The section on the Chordata is quite extensive, both as to form and function.

Although a good portion of Section 2 is devoted to the physiology of plant and animal forms, the third section, "The Operation of Biological Systems," deals in a more general way with such fundamental processes as nutrition, metabolism, growth, reproduction, and inheritance. Here, again, plant and animal forms are discussed comparatively, and the unity of living organisms is further emphasized. "The Evolution of Biological Systems" is well written, with emphasis on the historical development of the doctrine of organic evolution.

This reviewer has been impressed with the emphasis Dr. Gardiner has placed on the historical development of biological concepts and theories. This is best illustrated in the sections dealing with vitamins, hormones, and the doctrine of organic evolution. This type of treatment makes for a deeper appreciation, as well as for a clearer understanding of these topics.

The author writes with a smooth, easy style. The book is very readable and tells a story, rather than being a serialized collection of biological facts. As Dr. Gardiner has kept abreast of the field, the book is written in the light of the most modern discoveries in biology. The illustrations, many of them photographs, are numerous, clear, and good. Simplicity and ease of interpretation characterize most of the illustrations.

All things considered, the book is an excellent one and well suited to a course in biology where the instructor wishes to stress principles, rather than subjecting his students to an encyclopedia of facts.

WILLIAM O. PUCKETT
Department of Biology, Davidson College

The Medical Sciences

Global Epidemiology: A Geography of Disease and Sanitation: Africa and the Adjacent Islands, Vol. II. James Stevens Simmons *et al.* Philadelphia-London: Lippincott, 1951. 652 pp. $15.00.

The advent of World War II emphasized problems of international health and the transmission of disease. Surveys made by the Medical Department of the U. S. Army formed the basis for Volume I of this series, which provided data on India, the Far East, and the Pacific area. The volume has been well received and has provided the only adequate reference on the geographical distribution of diseases of that portion of the world. Volume II, as indicated in the preface, is designed to provide a concise summary, by political units, of current health conditions on the African continent. The success in achieving its objectives is appropriately attributed to the initiative of the Medical Intelligence Division of the Preventive Medicine Service of the Army, grants from the U. S. Public Health Service to the School of Public Health of the University of Minnesota, and to the cooperation of numerous health officials and research and educational institutions of many countries. A great deal of recent data was acquired by Ruth Alida Thomas on a survey trip in the winter of 1950 to Africa and various colonial headquarters in Europe.

The material is organized according to geography and climate, population and socioeconomic conditions (including vital statistics, social economy, food and nutrition, and housing), environment and sanitation (including flora and fauna), health services, and medical facilities, followed by a separate discussion of the more important diseases. Numerous small maps outline the distribution of various diseases or vectors. Section One includes the countries of the Nile Valley, the Ethiopian highlands, East Africa, the islands of the Indian Ocean, South Africa, Equatorial Africa, West Africa, and, in Section Eight, Northern Africa —a total of 45 countries being considered. A bibliography is appended to each section. A useful appendix includes maps of the principal tropical diseases and reprints "Health Hints for the Tropics," prepared by a committee of the American Society of Tropical Medicine. A complete index is provided.

Africa, as one of the great undeveloped regions of the world, is destined for an increasingly important future role. Colonial domination in the past has tended to minimize world interests in this continent, but international trade, travel, and the possibility of

military involvements have radically changed the situation. The authors have rendered a meritorious service in accumulating in a single volume, from widely scattered sources, the current knowledge of geography of diseases of Africa and other data on the health and sanitary conditions of the area. Future volumes in this series will be eagerly awaited by civilian and military public health and tropical medicine experts.

E. HAROLD HINMAN
School of Public Health, University of Oklahoma

An Atlas of Normal Radiographic Anatomy. Isadore Meschan with the assistance of R. M. F. Farrer-Meschan. Philadelphia-London: Saunders, 1951. 593 pp. $15.00.

The increase in numbers of x-ray technical personnel in recent years has been such that practically a whole new generation of radiographers requires training. Because equipment has become increasingly automatic, the necessity for acquiring physical information has diminished. As a result, greater emphasis can be placed during training on the other fundamentals of radiography, especially radiographic anatomy and projections.

Because good comprehensive sources of information about radiographic anatomy have been none too plentiful, the publication of Dr. Meschan's excellent book is especially welcome. In it, with the assistance of his brother, R. M. F. Farrer-Meschan, of Melbourne, he has assembled a compendium of radiographic anatomy that includes the following: basic anatomic information as it applies to radiography; the manner in which routine projections employed in radiography are obtained; a concept of the radiograph so obtained; the anatomic parts best visualized by these projections; anatomic changes with growth and development; and some of the more common normal anatomic variations.

The book is divided into 16 chapters, the first of which deals with the fundamentals of radiography, including concise explanations of the physics and geometry involved in the creation of an x-ray image. The second chapter contains a thorough discussion of the development of the skeletal system. The remaining 14 chapters are devoted to the radiographic anatomy of the body as follows: upper extremity; pelvis and lower extremity; skull; detailed consideration of various regions of the skull; brain; vertebral column and subarachnoid space; respiratory system; mediastinum; heart and major blood vessels; upper digestive tract; intestine beyond the duodenum; abdomen and peritoneal space; urinary tract; and genital tract. Each chapter contains introductory material on the basic anatomy of the area under discussion and a brief discussion of the radiographic examination.

In general two pages are devoted to each of the radiographic projections discussed. Each of these sections features a drawing showing the positioning of the patient and a reproduction and a labeled tracing of the radiograph. Practical hints on technique are also included.

The chapters on the skull, brain, vertebral column, and respiratory tract are very thoroughly presented. The author has included valuable material on the use of contrast media in connection with the examination of blood vessels in brain, heart, other viscera, and extremities. Body-section radiographs are occasionally employed to demonstrate certain anatomic features.

The reproduction of radiographs is of good quality. All in all, the book is very readable and is a valuable addition to the literature on the subject.

WILLIAM S. CORNWELL
Medical Division, Eastman Kodak Company Rochester, New York

Chemistry of Muscular Contraction. 2nd ed. A. Szent-Györgyi. New York: Academic Press, 1951. 162 pp. $4.50.

The chemical reactions involved in, and responsible for, muscular contractions present a fascinating problem to the biochemist and the physiologist, and Dr. Szent-Györgyi has given us in this new book a stimulating discussion of certain aspects of these reactions. Although called a second edition, the book is in reality completely new, as some of the chapter headings are about the only holdovers from the first edition.

Most of the book is concerned with the physical state of the muscle proteins (actin, myosin, and actomyosin) at rest and the changes they undergo during contraction. The ATP-protein and protein-protein interactions are the chemical reactions most thoroughly discussed; very little is said about ultimate energy sources and method of formation of ATP.

The book is written in a modified narrative style that, in the opinion of the reviewer, is occasionally a little too elementary for the subject matter. For example:

> The first question put by any chemist would be: What is or what are the substances in the juice responsible for eliciting this contraction? A little scientific cookery gives the answer, showing that they are ions and ATP.

On the whole, however, the style makes interesting reading. Recent evidence on specific points is presented and discussed, and then the author's theories of what the evidence means. This interpretation is perhaps the most interesting part of the book and will undoubtedly stimulate much discussion.

An intriguing chapter on thermodynamics, which attempts to analyze the mechanism of contraction by use of temperature-activity curves, is included. A number of excellent electron micrographs of various muscle preparations and isolated proteins are used in discussions on muscle structure.

Detailed procedures for the preparation of ATP, glycerol-extracted rabbit psoas muscle, myosin, actin, actomyosin-myosin B, and actomyosin threads are given. Some of these experiments would be excellent for inclusion in a laboratory course in biochemistry or physiology where muscle metabolism is studied.

R. C. MILLS
Department of Biochemistry, University of Kansas

A Textbook of General Physiology. Hugh Davson. London: J. & A. Churchill; Philadelphia: Blakiston, 1951. 659 pp. $7.00.

Thirty years ago William M. Bayliss, of University College, London, electrified an older generation of physiologists with his epoch-making *Principles of General Physiology*. Now, from the same laboratory comes a new book in the same field, destined to have a similar influence upon the present physiological generation. This is a very able review and summary of recent advances in many divisions of the subject and shows a remarkably clear and penetrating understanding of vital function in its more basic aspects. It represents an outstanding scholarly achievement in integration and interpretation of a literature that has grown greatly since Bayliss' day.

The text is supported by 1700 citations from the original literature, of which half appeared within the past seven years, and by 288 illustrations, most of which have never previously been used in any textbook. Particularly well done, among the 22 chapters, are the discussions of the structural proteins, of ionic equilibria and bioelectric potentials, of the kidney and osmotic regulation, of excitability and the propagation of the nerve impulse, of muscular contraction, and of photosynthesis.

This book is required reading for every physiologist, general or specialized, and for many others of the fraternity of scholars who come to physiology for fundamental interpretations in their related fields. The graduate student will find it a treasure house of well-organized information. As a class text for more advanced students at the undergraduate level, the book should find wide use.

WILLIAM R. AMBERSON

Department of Physiology
University of Maryland School of Medicine

The Electrical Activity of the Nervous System: A Textbook for Students. Mary A. B. Brazier. London: Pitman; New York: Macmillan, 1951. 220 pp. $5.00.

Unlike previous monographs on electrophysiology (Biedermann [1895], Schäfer [1940–42]), the present book is confined to the electrophysiology of the peripheral and central nervous system. After a brief introduction to the structure and function of the nervous system, the action potentials of the peripheral nerves are subjected to a detailed analysis, largely based on the work of Gasser, Erlanger, Lorente de No, and the Cambridge group. The application of this work to the physiology of the spinal cord is outlined, and the rival theories of synaptic transmission are sketched. Subsequent chapters deal with transmission of impulses from the sense organs to the central nervous system (Adrian-Bronk law) and illustrate the role that the study of action potentials has played in the exploration of the sensory projection areas of the cerebral cortex. A chapter on the electrical activity of the brain serves as a basis for the study of the electroencephalogram in man, which is briefly discussed in its physiological and some of its pathological aspects. The book is written with great clarity, amply illustrated, and provided with an adequate list of references at the end of each chapter. Print and binding are excellent. Brazier's work can be recommended without reservations to students of physiology and electroencephalography.

E. GELLHORN

Department of Physiology
University of Minnesota Medical School

Survey of Compounds Which Have Been Tested for Carcinogenic Activity. Public Health Service Pub. No. 149, 1951. 2nd ed. Jonathan L. Hartwell. Order from Supt. of Documents, GPO, Washington, D. C. 583 pp. $4.25.

One of the most important tasks of cancer research workers is to find the cause of cancer and to devise a method for its prevention. It has long been suspected that prolonged or chronic irritation with certain substances can cause cancer. In 1775, Percival Pott noted that cancer of the scrotum was unusually common among chimney sweeps. He thought that in these people the disease seemed to derive from a lodgment of soot in the rugae of the scrotum. This observation forms the basis for our present knowledge of the possibility of producing cancer with pure chemicals. It was not until 1915, however, that experimental production of cancer was achieved. Yamagiwa and Ichikawa then succeeded in producing cancerous growths in rabbits' ears after long-continued painting with coal tar. Kennaway and Cook, in 1932, first produced skin cancer in mice by a pure chemical, 1,2,5,6-dibenzanthracene. Since then a great number of chemicals have been tested for carcinogenic activity. It became apparent, therefore, that a complete survey on this important subject was imperative, and fortunately Dr. Hartwell has unselfishly undertaken this task and has done it well.

The present book lists 1329 compounds, of which 322 were reported to cause malignant tumors in animals and 35 others to induce only benign tumors. As in the first edition, the present work lists only simple compounds: (*a*) inorganic compounds; (*b*) organic compounds—namely, aliphatic, monocyclic, bicyclic, tricyclic, tetracyclic, pentacyclic, hexacyclic and higher, azo compounds, steroids, heterocyclic, and unclassified compounds. Such complex mixtures as tars, irradiated steroids, and articles of diet are not included.

Hartwell points out the pitfalls in the use of a survey to affirm or deny a proposed theory of carcinogenesis, or a fancied correlation between carcinogenicity and chemical structure. Sometimes it is not realized that lack of carcinogenic potency implies such a lack only under limited experimental conditions. There are pronounced differences in the response of different species to the action of carcinogenic compounds, as in the case of the mouse. There is evidence

that some compounds that are negative in the mouse can induce tumors in other species. Some compounds have given negative results when applied to the skin but have been quite active when injected subcutaneously. Compounds potent for the skin and subcutaneous tissue are found to be inactive when introduced directly into the liver. The susceptibility of the lungs does not necessarily parallel that of the skin or the subcutaneous tissue. Details of the mode of administration may also influence results. Average latent period may affect the expression of carcinogenic potency, and diet, too, may be an important factor. Another pitfall is the attempt to carry over to man conclusions based on animal experiments. We do not know whether man is more or less susceptible than mice to particular carcinogens. Some animal species, such as the rat, rabbit, and dog, are much more resistant to certain chemical carcinogens than is the mouse, and vice versa, and in the monkey none of the powerful pure carcinogens has been shown to produce tumors. (Recently, Sugiura, Smith, and Sunderland succeeded in producing papillomas and squamous cell carcinomas in monkeys by painting with catalytically cracked petroleum (*Cancer Research*, 9, 631 [1949]).

Although no evidence has been found that such cancer-producing chemicals exist in the normal body, it is possible that they may arise under abnormal conditions from some chemically related substances known to be present. Knowledge of the production of cancer with pure chemicals may provide the key to the secret of cancer formation, prevention, and cure.

Jonathan Hartwell deserves praise for this valuable addition to cancer literature, and students of cancer may greatly profit from it. The bibliography includes 2055 papers, written by 1744 scientists, alone or jointly.

KANEMATSU SUGIURA

Sloan-Kettering Institute for Cancer Research, New York

Outline of Fundamental Pharmacology: The Mechanics of the Interaction of Chemicals and Living Things. David Fielding Marsh. Springfield, Ill.: Thomas, 1951. 219 pp. $6.00.

Since the classical monographs of A. J. Clark, published in the thirties, no comprehensive treatise has appeared on the general principles of the mode of action of drugs. Yet, the great advance of pharmacology in the past decade has led to many changes in our general concept and rendered this science much more complex. Marsh's book thus supplies a long-felt want.

This book is ideal for introducing the student to pharmacological research or for showing the interested scientist what pharmacology and bio-assay really are. In the first chapter, pharmacology is defined by its aims, problems, and history, but the book as a whole serves excellently to extend this by demonstrating its methods, its "way of thinking," and its spirit. The succeeding chapters deal with factors influencing drug action (age, sex, weight, environment, pathologic conditions, other drugs, species variation, etc.); the principles of quantitative pharmacology and bio-assay; mode of action of drug antagonism and synergism; experimental aspects of the site of action of drugs; principles of the absorption, distribution, and fate of drugs in the organism; mechanism of action of drugs; and relationship between chemical constitution and biological action. In an appendix, the applications of pharmacology are briefly described. All chapters are masterfully illustrated with specific examples and highlights from the history of pharmacology. The entire structure of the book demonstrates great pedagogic ability. The book serves as a valuable guide into pharmacological bibliography, listing (partly in the text, partly among the references) the most important handbooks, general references, and typical papers dealing with the points under consideration. Ethical and legal aspects of pharmacology and allied sciences are discussed.

To young men interested in the medical sciences, the book of Ramon y Cajal (*Regeln und Ratschläge zur Wissenschaftlichen Forschung* [1933]) on the philosophy of medical research is usually recommended. If they then show specific interest in pharmacology, Marsh's book would be the ideal reading material.

CLARA M. AMBRUS

Department of Pharmacology and Biochemistry Philadelphia College of Pharmacy and Science

Psychology

The Study of Instinct. N. Tinbergen. New York: Oxford Univ. Press, 1951. 228 pp. $7.00.

The present volume deals with the scientific study of behavior or, as the author prefers to call it, ethology. The author seeks an answer to the age-old question: Why does the animal behave as it does? The book is a study of the biology of innate behavior. It considers the relationship between specific experimental and observational material and neurophysiology, ecology, taxonomy, psychology, and even sociology.

In discussing psychology, the author distinguishes between what he calls the largely nonobjective psychology of Europe and objective American psychology. He correctly points out that objective American psychology has not emphasized the study of innate behavior. He feels that this failure is due to the fact that many American psychologists do not recognize that learning and the other so-called higher psychological processes must be considered as secondary modifications of innate mechanisms. He contends that a study of the learning process should be preceded by a full knowledge of the innate foundations of behavior, preferably obtained under natural or field conditions.

Care must be exercised by the reader in remembering the way many technical terms are used by the author. The term "sign stimulus," for example, has a

special meaning in the book. Animals react only to a small segment of all the changes in the environment that activate their sense organs and presumably also their central nervous systems. This selection of certain energies as sign stimuli by the organism is indeed held to be basic in understanding instinctive behavior.

An example of response to only a small part of a stimulus pattern is the reaction of birds such as ducks to flying birds of prey. By experimentation it is shown that the releasing value of the sign stimulus in this situation may be related to specific and identifiable characteristics of the movement and shapes of cardboard models of birds. A model was used with symmetrical anterior and posterior wing edges. It had a short protuberance at one end and a long one at the other. When sailed with one end forward the model had a short neck and a long tail. This movement elicited escape movements in ducks. When flown with the long neck forward it did not elicit such actions.

By a wealth of illustrative detail taken from the study of many animal forms, such as fish, birds, and insects, it is pointed out that the causation of behavior is more complex than has generally been assumed. Many internal and external factors act upon central nervous structures at all times in determining behavior. Occasionally, automatic central nervous system units "explode" and produce muscle actions in the absence of external releasing stimuli. This fact has led Lorenz, a collaborator of Tinbergen's, to put forward the rather specific hypothesis that some instinctive responses are controlled by specific endogenous neural factors.

The author points out that the exact study of behavior in relation to evolution has lagged behind the study of comparative morphology.

The final pages of the volume are devoted to the study of the behavior of man. Here the relationship between physiological, psychological, and, in the present author's term, ethological approaches to an understanding of human action are brought out by reference to such phenomena as food-seeking.

This volume is an expansion of lectures delivered in New York at the American Museum of Natural History and at Columbia University. Its pages summarize much ingenious experimental work and present a point of view that is bound to have an influence on later behavior studies.

The concrete evidence of the book makes the American anti-instinct psychology of a few decades ago seem bizarre indeed. Some scientifically trained objective students of behavior who read its pages may wish for more rigorous definitions of some of the concepts presented. Such students may also feel that the failure of the author to provide information on controls and details of statistical analysis detracts somewhat from the value of much of the brilliant work he reports.

LEONARD CARMICHAEL
Department of Psychology, Tufts College

Vocabulaire de la Psychologie. Publié avec la collaboration de L'Association des Travailleurs Scientifiques. Henri Piéron, Ed. Paris: Presses Universitaires de France, 1951. 356 pp. 1300 fr.

Assisted by 15 collaborators from the Association of Scientific Workers, Piéron has edited a dictionary of some 3700 terms commonly employed in French psychological writings. American psychologists will recall that Piéron served on the editorial board of the Warren dictionary, published in 1934. In a prefatory note he remarks that the Warren opus is now out of date. The rapid developments in clinical, industrial, and educational psychology have brought many new terms and concepts into use during recent years. In particular, the impact of new theoretical constructs has revolutionized the field of psychology. The precise vocabulary of psychophysics, once the central interest of scientific psychologists, has receded into the background. Terms and concepts representative of enthusiasm for dynamic, molar approaches to the field have been introduced rapidly into psychological writing, both in this country and abroad. The vocabulary is in a state of flux. Except for basic terms still in current use to denote phenomena in psychophysics, nosology, neurology, anatomy, and other areas of knowledge from which contemporary dynamic psychology has developed, the older dictionaries are inadequate. Not only is the vocabulary of psychology constantly growing, but the denotations and the connotations of many traditional words have been radically altered in current use.

This dictionary is of considerable interest to the American student of psychology. First, it affords an opportunity to discover what terms and concepts used in this country have influenced his colleagues in France. For instance, there is some emphasis upon TAT, Rorschach, and Rosenzweig PF—but the omissions indicate a lack of enthusiasm for *tests de projection*. Dynamic concepts in psychopathology receive scant attention, whereas the traditional nosological syndromes are emphasized. Concepts from social psychology reflect a conservative point of view, although a few of the Lewinian terms are briefly defined. Other evidence will be found to justify the inference that French psychology is more parochial than American. Second, the American psychologist will be interested to discover those of his colleagues whose work has affected contemporary French psychology. For example, Sheldon has apparently attracted more attention than Hull. Similarly, there is an opportunity to survey the processes of selective perception with reference to contemporary British psychology. It is the reviewer's inference that classical German psychology is more adequately represented here than are the concepts now used by American or British psychologists.

A few minor errors have crept in. Jost's law, for example, is not sharply differentiated from retroactive inhibition. Dementia praecox is defined from a static point of view, with no inclusion of terms designating the psychodynamic aspects of the disorder. An initial

in F. W. H. Myers (p. 318) is incorrect. On the whole, however, the book is remarkably free from typographical errors. It will prove to be an invaluable addition to the personal library of American psychologists, and its purpose seems to have been accomplished in an admirable manner. The American student of psychology is likely to use it for quite a different purpose from that intended by Piéron and his co-workers—namely, as a convenient exercise in overcoming his own ethnocentrism.

PHILIP L. HARRIMAN

Department of Psychology, Bucknell University

Cerebral Mechanisms in Behavior: The Hixon Symposium. Lloyd A. Jeffress, Ed. New York: Wiley; London: Chapman & Hall, 1951. 311 pp. $6.50.

The Hixon Symposium has significance for anyone concerned with the theory of human behavior and even for those who wish to understand some of the contraptions man himself has built—namely, computing and cybernetic machinery. The book has one of the defects of symposia, being a series of separate reports by experts not too much interested in one another's views nor primarily giving a complete account of the field. However, the excellent discussion by each of the experts on the other papers, and by an equally distinguished panel of discussants, does much to fill in the gaps and link the main papers. The job of editing is splendidly done, and the reader will find that he need not be an expert in the theory of automata to understand von Neumann, for example, nor a professional psychologist to understand Lashley (although it would be too much to expect that the nonspecialist will follow in all detail).

The first paper, by John von Neumann, deals with computers and so on as related to brain function; the second, by Warren S. McCulloch, with brain function as it bears on the theory of computers and with mathematical "models" of brain function. This reviewer (who has admitted elsewhere an incapacity to understand papers in this field) is happy to report that he found these papers readable and stimulating. They might be generally recommended as an introduction to the more technical literature.

The remaining papers are by psychologists. K. S. Lashley discusses serial organization in speech and complex motor skills, clarifying a general problem instead of reporting specific research. Heinrich Klüver reviews his earlier work on the temporal lobe and discusses more recent experiments on "extracerebral" (biochemical) agents in behavior (this paper may be the least easy to follow as far as organization is concerned). Wolfgang Köhler describes a specialized experiment in perception (also reported with Held in SCIENCE, 110, 414 [1949]). Ward Halstead summarizes his book *Brain and Intelligence.* The volume concludes with Henry W. Brosin's pulling together the preceding material and linking it to current psychiatric problems.

In a period of rapid development in neurophysiology, a 1948 symposium may be somewhat out of date in 1952, which explains the omission of some important topics. There is nothing on the extrasensory thalamic mechanisms (Morison, Jasper, Magoun, *et al.*), on such work as that of Bender and Teuber or of Woolsey on the mechanics of perception, or that of Bard and many others on emotion and the amygdala cingulate gyrus, and so forth. The book did not, therefore, give a complete survey of the field even in 1948. But as a symposium, and especially if the apparently amicable little digs in discussion sessions are not neglected, the reader will find this a stimulating, readable, and (most of the time) authoritative work.

D. O. HEBB

Department of Psychology, McGill University

Language and Communication. George A. Miller. New York–London: McGraw-Hill, 1951. 298 pp. $5.00.

This is intended as an advanced college text on the psychology of speech and communication. The author, in a foreword, correctly says, "Most teachers will find that they are able to lecture far beyond the content of the text in several of the chapters, but few will be able to do so for every chapter." He suggests that the book divides into two parts—that courses for students with backgrounds in linguistics and the engineering sciences should emphasize the first part, and courses for students in psychology and sociology should emphasize the second.

It ought to be added that the general reader will find throughout much that is interesting and novel to him. Studies of speech and hearing made by Harvey Fletcher, N. R. French, and other Bell Telephone Laboratories engineers are featured, as is another development from the same intellectual center—namely, C. E. Shannon's treatment of information. (It is remarkable that, although in 1609 Lord Bacon clearly stated the essential characteristics of a code, elaboration of his approach was not begun until the 1920s.)

Chapter titles include: "The Phonetic Approach," "The Perception of Speech," "The Statistical Approach," "Rules for Using Symbols," "The Role of Learning," "Verbal Habits," "Words, Sets, and Thoughts," and "The Social Approach." The excellent index refers to many investigators, with repeated mentions of the work of such people as S. S. Stevens, E. L. Thorndyke, M. Wertheimer, G. U. Yule, G. K. Zipf. Relevant publications by S. C. Dodd are not described, and E. U. Condon is inadvertently assigned the initials E. V.

The book is pleasantly printed; it appears as work done in part at Harvard under an ONR contract. To notice omissions from this excellent pioneer compilation is not particularly profitable, since the author himself emphasizes that selection was unavoidable. Yet the description of vowel sounds, sung, spoken, or whispered, as recurrent, damped oscillations might

well have been included. Telemetering and automatic computing machines are not mentioned, although, with the rapid progress engineers are bringing about here, some well-deserved future edition may alter the statement that "In most communication systems the source of the information is a human being."

JOHN Q. STEWART

Princeton University Observatory

The Earth Sciences

Mathematische Grundlagen der höheren Geodäsie und Kartographie: Das Erdsphäroid und seine konformen Abbildungen, Vol. I. R. König and K. H. Weise. West Berlin: Springer-Verlag, 1951. 522 pp. Cloth DM 49.60; paper DM 46.

In the field of theoretical geodesy and cartography, the Germans have enjoyed an enviable position from the time of the mathematician C. F. Gauss, whose fundamental work on conformal representation of surfaces upon planes and other surfaces might properly be called the beginning of modern geodesy. His papers on cartography gave the rigorous mathematical formulation of projections already envisioned 50 years earlier by J. H. Lambert. The two-volume treatise by F. R. Helmert, *Die mathematischen und physikalischen Theorieen der höheren Geodäsie,* has been the bible of geodesists through the years, although important and outstanding contributions have appeared in recent years—notably C. F. Baeschlin's *Textbook of Geodesy.* But the present work of König and Weise is that once-in-a-century type of outstanding classic in a field.

Part I, Chapters 1 through 10, under the general title "The Earth-spheroid and its Conformal Projection," with which this review is concerned, is the first volume of an extensive, but compact, two-volume treatise. Parts II through IV, Chapters 11 through 22, under the general title "The Fundamental Problem of Higher Geodesy," will appear as the second volume.

The following remarks seem apropos concerning the general format of Volume I. Immediately after the table of contents there is a most useful summary explanation of the mathematical symbols and notations used in the text. Some of the notations, such as those used for geographical latitude and longitude, are not those commonly used, but this is a minor point and in no way detracts from the masterful treatment. Throughout the volume, figures are plentiful and many are done in two colors for clarity; the bibliography includes all the important extant works in the fields of geodesy and cartography. A useful index concludes the volume.

In Chapter 1 are found the constants of the oblate ellipsoid of revolution (spheroid); numerical values of the constants for the Bessel and International Spheroids; parametric representation of the meridian ellipse by means of the geographical latitude; arc element of the meridian; curvatures associated with the spheroid; trigonometric developments and power series expansions for the various curvatures and associated functions; the meridian arc, complex representation and power series developments in terms of geographical latitude; geographical latitude as a function of meridional arc; the parallel arc element; the surface element and evaluations. The chapter concludes with a summary of the power series developments obtained, including middle latitude formulas.

Chapter 2 includes the parametric representation of a revolute by means of geographical latitude and longitude, with the specializations to the sphere and the spheroid; the linear element of the spheroid; the isometric latitude for the sphere and spheroid; the isothermal parameters; three complex fundamental surface variables by means of which the conformal projections are characterized; relationships between these three complex fundamental variables for the sphere and spheroid; the transverse Mercator projection of the sphere; Gauss-Krüger projection of the spheroid; summary of complex variables for points, curves, and fields.

Chapter 3 deals with the conformal projection of one plane upon another by means of the analytic function of a complex variable; the curvature of plane curves; specific determination and continuation of the projection on a large scale; examples of conformal projections by means of elementary functions; conformal projections by means of elliptic functions of elliptic integrals; conformal projections by means of algebraic functions and integrals.

In Chapter 4 are found the geometric relations between the three fundamental complex variables for characterizing the conformal projections (originally defined in Chap. 2); application to the particular case of the sphere; projection of the spheroid by means of exponential functions and their linear transformations; a summary of the results obtained. In Chapter 5 the analytic developments in series are presented for the relationships between the three fundamental variables and their exponential functions; the conformal projection of the spheroid upon the sphere; a summary of the series developments; summary of the singular points of the various projections discussed; numerical examples of the computation of the fundamental variables.

Chapter 6 develops the conformal projections of the spheroid upon a plane (Mercator, transverse Mercator, Gauss-Krüger); the spheroid upon a sphere; the spheroid upon a second spheroid. A summary of the projections discussed is given at the end of the chapter, and numerical examples of these projections are presented.

The stereographic projection (in its various forms, polar, equatorial, etc.); spherical projection; and the general projection by elemental arcs for spheroids form the subject matter of Chapter 7. A summary of the important projections is followed by numerical examples. The transformations of isothermal coordinate systems is the subject of Chapter 8; they are discussed with respect to the Gauss-Krüger system, the Lambert spherical projection, etc. Chapter 9 is concerned with some of the already established projections of the reference ellipsoid upon the plane, upon the sphere, or upon a second spheroid.

Chapter 10 is called "Aids from Analysis." It treats of complex numbers and elementary functions; differentiation of a product (the product formula of Leibnitz); differentiation of a function of a function (composite function); general analytic functions and their representations; exponential series; general ordering theorems; general exponential series (Weierstrass-Laurent series); the particular case of trigonometric series; trig-

onometric functions from general exponential series, in particular from trigonometric series; the combination of two general exponential series, particularly of two trigonometric series; reversion from general exponential series, especially from trigonometric series; exponential series in two variables, reversion of series; two-dimensional interpolation.

This chapter-by-chapter account of the contents of Volume I only implies the systematic, skillful development of the theory. By defining three fundamental parameters early in Chapter 2, by means of which the conformal projections may be generated, various relations among them are established and the necessary power series expansions, etc., developed for the characterization and computation of the conformal projections—thus giving a logical and systematic development of the theory of conformal projection of the spheroid on a plane, a sphere, or another spheroid.

This monumental work is a "must" for anyone interested in the mathematical theory of geodesy and cartography.

PAUL D. THOMAS
Computing Laboratory, Ballistics Research Laboratory
Aberdeen Proving Ground, Maryland

***The System of Mineralogy* (*Dana's*)**, Vol. II. 7th ed. Charles Palache, Harry Berman, and Clifford Frondel. New York: Wiley; London: Chapman & Hall, 1951. 1124 pp. $15.00.

Since 1837, when the first edition appeared, *Dana's System of Mineralogy* has been in constant use the world over as an authoritative reference work. It has long been characterized as the mineralogist's bible.

The sixth edition appeared in 1892, and 52 years elapsed before Volume I of the seventh edition was issued in 1944 under the authorship of Charles Palache, Harry Berman, and Clifford Frondel, of Harvard University. Shortly afterward Dr. Berman met a tragic death in an airplane crash at Prestwick, Scotland. Because of the many advances made in mineralogy and related sciences since the sixth edition, it was necessary to introduce significant changes in the new edition. These changes are discussed in detail in the preface and introduction to Volume I, which also includes an extensive bibliography of 37 pages.

Volume I contains descriptions of the elements, sulfides, sulfosalts, oxides, and related minerals. In Volume II, the halides, carbonates, nitrates, iodates, borates, sulfates, selenates, tellurates, chromates, phosphates, arsenates, vanadates, antimonates, vanadium oxysalts, molybdates, tungstates, and related minerals, as well as organic compounds, are described.

The descriptions of the individual minerals have been uniformly well prepared. In each case there is a comprehensive bibliography, so that the original sources can be readily consulted. Being encyclopedic in scope, the volume describes many substances with doubtful status as minerals. This is well indicated by such statements as "probably identical with ———," "is a mixture of ——— and ———," "needs further verification," and the like.

Many minerals have been reclassified and their crystallographic orientation has been changed, as a result of the new data obtained by the use of modern x-ray methods and new chemical analyses. The crystallographic data are given in terms of measurements with the two-circle goniometer, making it difficult for those not familiar with this type of goniometry to use the tables of angles readily.

Volume II is a noteworthy addition to scientific literature and will be widely used by all interested in minerals. The authors are to be congratulated on the thorough way in which a stupendous task has been accomplished. It is hoped that the third and final volume of this monumental work, which will describe silica and the silicates, may be issued before long.

EDWARD H. KRAUS
Mineralogical Laboratory
University of Michigan

The Formation of Mineral Deposits. Alan M. Bateman. New York: Wiley; London: Chapman & Hall, 1951. 371 pp. $5.50.

This volume aims to acquaint the reader who may lack a basic knowledge of geology and mineralogy with the way deposits of industrially important metals and minerals occur in nature and how they have been formed. Certainly there is need for a work with such an objective. Public interest in mineral resources is growing as the result of more general realization that metals and minerals are the basis of modern industrial development. This interest is mixed with concern over the alarming consumption of mineral resources and the consequent necessity of searching for new occurrences to replenish supplies being depleted.

The author's manner of treatment, as stated in the preface, is designed to serve the scientist, the engineer, the industrialist, the student, and the general reader interested in mineral substances. This is a difficult task with a subject as complex as mineral deposits. To be effective the treatment must be sound and authoritative, cover the essentials, yet not presuppose too great a knowledge of geology and mineralogy. Professor Bateman's volume measures up very well indeed.

It could not have been written by a person with a more appropriate background—a teacher of the subject, a professional economic geologist of world-wide experience, a government servant with broad responsibilities in development of mineral supplies and mineral procurement, the editor of an international magazine devoted to economic geology, and the author of a leading textbook in the field. As the result of following closely the plan of treatment of equivalent material in the author's text *Economic Mineral Deposits* (1950), the book is sound, more comprehensive, and better balanced than one would normally expect. Bateman has resisted the temptation to interest the casual reader by undue emphasis of the sensational at the expense of providing a complete, balanced picture. It follows, then, that the volume is not easy reading for the person without serious interest. Of

course, a basic knowledge of geology and mineralogy on the part of the reader would contribute to the ease of understanding and appreciation of the subject matter. However, throughout the book a conscious attempt is made to develop the knowledge of geology and mineralogy required for an adequate understanding of the formation of mineral deposits. Technical words are held to a minimum, and a brief glossary is appended to explain the technical terms used.

CARL TOLMAN
Department of Geology and Geological Engineering
Washington University

The Tectonics of Middle North America: Middle North America East of the Cordilleran System. Philip B. King. Princeton, N. J.: Princeton Univ. Press, 1951. 203 pp. $3.75.

This book is a progress edition of a larger work on the "Tectonics of North America," which the author hopes to complete later. Because of press of other duties, he has deemed it best to make available the portions already prepared. These are: "Southern Portion of the Canadian Shield," "The United States East of the Rocky Mountains," and adjacent parts of northern Mexico.

The text is supplemented by 52 cross sections, maps, and diagrams, most of them edited and modified from publications of other authors, and all especially redrafted. The source of each and, generally, the nature of the modifications are given in a special list at the end. The large regional maps planned for the final work could not be included, and the reader is referred to the American Geographical Society *Map of the Americas*, the American Association of Petroleum Geologists *Tectonic Map of the United States*, and the Geological Society of America *Tectonic Map of Canada*.

The treatment is arranged under three major headings: "The Central Stable Region" ("The Interior Lowlands," 39 pp.; "The Canadian Shield." 23 pp.); "Paleozoic Structure Southeast and South of the Central Stable Region" (92 pp.); and "The Coastal Plains" (24 pp.).

The free use of structure sections and the assembly and digest of the literature of the various regions make this an extremely useful book for the student of continental tectonics. Each section is accompanied by a bibliography which, though it makes no pretense of being complete, contains most of the recent pertinent references and is full enough to serve as a starting point for more detailed studies. The print is good, and the line drawings are remarkably clear and distinct.

The foreword states that the work was prepared to fill a need "for a modern description of the tectonic features of the United States for class-room use and as an explanation of the Tectonic Map of the United States." In the main, the work is just that, and it is a very important contribution.

As a descriptive work for classroom use, it seems to this reviewer to be marred by the author's adoption and inclusion of certain controversial concepts of tectonics and of sedimentation. These, being taken more or less for granted, will inevitably have the effect of orienting the thinking of the generation of students who use the text in the direction of those concepts. In a book designed mainly as a descriptive text on the tectonics of a region, controversial ideas, with their related classifications, should not be used in the body of the text as if they were established concepts of tectonics and sedimentation—for example, the concept of the tectogene; the idea that orogeny acting on mobile belts results in consolidation of the disturbed regions so that they resist further compression; or the concept that carbonates and clean-washed sandstones are miogeosynclinal, whereas slates, shales, arkoses, and graywackes are eugeosynclinal. Such ideas might entirely properly and better be discussed in a separate chapter dealing with theoretical considerations.

JOHN L. RICH
Department of Geology and Geography
University of Cincinnati

Theoretical Petrology: A Textbook on the Origin and the Evolution of Rocks. Tom F. W. Barth. New York: Wiley; London: Chapman & Hall, 1952. 387 pp. $6.50.

Petrologists of every hue, from magmatists to transformists, have looked forward to the appearance of this volume by Barth—for he has recently shown notable leanings toward transformist views and many have wondered whether he would now go the whole way. There will be disappointment in the ranks of the extreme transformists, if we may take as representative of their attitude the statement of D. L. Reynolds: "Magmatists, adopting a defeatist attitude, have begun to conceive of petrology as a restricted branch of physical chemistry." Far from rejecting physical chemistry, Barth says in his preface, "Now that experimental methods have led to the synthesis of minerals and rocks and the determination of their thermodynamical constants, petrology has become physico-chemistry applied to the crust of the earth." Yet there will be disappointment among magmatists, too. Barth again expresses and apparently still adheres to his view that granites may be formed by condensation of a cloud of ions!

This presentation of extremist views, often without distinct indication of choice, is characteristic of the book and may, perhaps, be regarded as its strength, if it is to be used principally for teaching purposes and in the hands of a discriminating teacher. Without proper guidance a student is likely to find it rather bewildering.

The book begins with a brief discussion of the earth as a whole, its origin and development, and then passes to a consideration of the rocks of the crust. In a decidedly unorthodox arrangement, the sedimentary rocks are considered first in spite of their derivative character. There is just enough consideration of mineral substances in the preliminary discussion of the whole earth, however, to render this

arrangement reasonably satisfactory. Only about 20 pages are devoted to sediments, so that the book must be regarded as dealing almost exclusively with igneous and metamorphic types. It is principally with their problems that the author has been concerned throughout his career in the field and in the laboratory.

In introducing the igneous rocks he points to lavas as the only indubitably igneous or once-molten rocks. For certain deep-seated types that have usually been classed as igneous, he suggests that some doubts should be entertained, and the implication is strong that he himself thinks that very large masses (batholiths), and therefore most granites, are not of igneous origin—a view much in vogue in these times and one with which this reviewer has little sympathy.

In his treatment of the igneous rocks the author discusses the laboratory studies of silicate melts and the equilibrium diagrams that have resulted therefrom, making good use of these in describing the crystallization of magmas. He leans strongly toward the view that the diversity of igneous rocks has arisen largely through fractional crystallization of magmas, although he does not exclude the other processes involving selective transfer of material. Here the reviewer finds himself in complete agreement, and also regards as excellent the author's discussion of the manner of occurence and natural relationships of igneous rock types.

With the metamorphic rocks we reach varieties on which our knowledge is much more limited. They therefore present a major challenge and are at the moment the object of much investigation, both on the theoretical side and in the field and laboratory. The possible effects of pressure and stress become of equal importance with those of temperature, which is the principal consideration with the igneous rocks.

Barth discusses, as fully as possible in this small volume, the present state of knowledge and conjecture in this varied approach to the problems of metamorphism. Possible mineral assemblages under different conditions of temperature and pressure are treated in considerable detail. It is often not sufficiently emphasized how uncertain is our knowledge. For example, in a diagram on page 255 and again in the text on page 269, a rising-temperature inversion of triclinic microcline to monoclinic orthoclase near 700° is presented as if it were an established fact. Actually nothing is known of the temperature of this change. Indeed, no less an authority on rock minerals than Eskola has recently raised the question whether microcline may not be the high-temperature modification of potash feldspar.

It should be realized, however, that such a wealth and variety of interpretation are presented that the author could not hope to discuss all the pros and cons in one small volume. It is well, therefore, to end on the note already struck, that in the hands of a discriminating teacher the book will be a valuable addition to petrologic literature.

NORMAN L. BOWEN

Geophysical Laboratory
Carnegie Institution of Washington

Book Review Index

Comments and Communications

"Official Views" from the GPO

WITH the last publications I received from the United States Government Printing Office, there was enclosed a standard slip bearing a message over the printed signature of Roy B. Eastin, Superintendent of Documents. It begins:

> Thank you for your order which is returned for your files. The publication you requested is enclosed. This book is only one of many thousands of interesting and informative United States Government publications which are available to you at small cost from this Office. *Each is completely authentic and represents the official views of your Government* [italics mine].

Innocuous as the purpose of this last statement may perhaps be, the implications incite apprehension. There is considerable precedent for the government to propagate as "official views" matters of policy and security that are its peculiar concern. There is cause for vigorous protest, however, when all scientific publications emanating from the Government Printing Office are included under a blanket endorsement of "completely authentic" and "official views." Is the day coming when Washington will have the only orthodox word about nomenclature (in both the physical and the biological sciences), conservation, phylogeny, and other scientific areas? This is the point to which the doctrine, if carried to its logical absurdity, would obviously lead us.

Lysenko has been assailed for promulgating the official views of his government, and we, fortunately, have been free to judge that they and it are in error. It will be a great tragedy if the public is led to believe that the results of research and publication conducted under the auspices of our government, true as we may believe them to be, become *ipso facto* "completely authentic" and "official views."

EDWARD G. VOSS
Department of Botany, University of Michigan

Circling Planets

I WAS interested in the comments of Cyrus N. Ray and David I. Macht regarding certain interpretations of expressions appearing in the Bible, especially those pertaining to the shape of the earth and to its orbits. I would suggest that both read *The Epic of Izdubar*, written by a nameless poet on imperishable tablets of a Babylonian library some 3950 years ago. The original tablets are now in the British Museum and, oddly, are little known to the Western reader. From this and similar material, one would infer that considerable material appearing in the Bible was taken from these works of greater antiquity. All works of the ancient Assyrians who dwelt on the banks of the Tigris and Euphrates, over 4000 years ago, were written in the cuneiform, or old Chaldean, characters and on a substance that could withstand the ravages of time, fire, and water. These are in their original form, unglossed, unaltered, and ungarbled, and in this respect Chaldean character records are actually superior to those of the Hebrews, the Greeks, or the Romans. Much of the material is in poetic form, though it is quite unmetrical. Like Hebrew poetry, the verses are proportioned and emphasized by means of parallelism, and they are by no means lacking in sublimity of expression. The following quotations from this epic poem are not to be considered theological disputation, and readers can interpret them as they see fit:

> And lifts his mighty arm across the sky,
> And strikes the sun as it goes roaring by;
> The fiery world with whiter heat now glows,
> While a vast flood of flame behind it flows,
> That curling, forms bright comets, meteors,
> And planets multiply, and blazing stars;
> Upon the ambient ether forming suns
> That through new orbits sing their orisons.
> Hell's gate they guard with Death's remorseless face,
> And hurl the sun around the realms of space,
> E'en swifter than the lightning, while it goes
> Along its orbit. . . .
> And countless stars thus driven whirl around,
> With all the circling planets circling, round.
> Around the whole Expanse, grand cestes spread
> O'er paths sidereal unending lead,
> As circling wheels within a wheel they shine.
> . . . Thou who on the axis of Heaven dawnest,
> in the dwellings of the Earth, revolvest.
> The path they take behind the rising sun
> The setting sun they pass—with wings have flown
> The scorpion men, within wide space have gone,
> Thus from his sight the monsters far have flown.
> [*Note*: These monsters were supposed to fly ahead of the sun and, as it passed, guide it along its orbit.]
> A girdle spans the Heavens with pure light, that shines around the River of the Night,
> Within the circling rays a host appears
> The singers of the skies, as blazing spheres.
> Not so, my King. Behold this glorious sphere,
> Where gods at last take all these souls from here.

R. DE ROHAN-BARONDES
1031 South Broadway, Los Angeles, California

A Blast for "Formicology"

"The origin of new terms for old objects may be in part adaptive change: the new terms may express more truly than the old the real nature of the entities. . . . The minting of unnecessary terms probably results also from the relative indifference of some authors to the interests of their readers—not to mention the possibility of their own occasional conceit or vanity" (SCIENCE, 109, 417 [1949]).

Reading the above quotation brought to mind a recent case of counterfeit coinage that has achieved considerable currency. I refer to "formicology," which

is used occasionally (but all too often) for the study of ants. I have not been able to find the word in any dictionary. The only word I can find is "myrmecology," which was apparently considered satisfactory by the old masters in this field, notably Mayr (as early as 1862), Emery, Forel, and W. M. Wheeler. That Dr. Wheeler did not feel the need of a new term is especially significant for two reasons: (1) he was addicted to the coinage of new terms; and (2) his thorough knowledge of classical languages would have enabled him to detect any flaws in the derivation of myrmecology.

But there is a more serious indictment of "formicology" than mere superfluity: It is incorrectly derived from the Latin *formica* and the Greek *logia*. In spite of precedents, such hybrid derivations are not excusable. I once heard W. M. Wheeler inveigh caustically against a well-known entomologist who had coined in the same manner a large number of new generic names. "Bastard[1] derivatives," he called them.

What I can't understand is why anyone should have thought a new name was needed for the study of ants. Perhaps someone felt that "formicology" would be self-explanatory (since all ants are in the family Formicidae) to entomologists in general, whereas it might be necessary to consult a dictionary to learn the meaning of myrmecology. But in that case "formicidology" would have been more appropriate, though not better derived. By the same reasoning "entomology" would become "insectology" and "zoology" would be "animalology." But if that unknown coiner had really wanted to make things easier for the layman, he would have gone all out and minted "antology," a term eminently appropriate for a subdivision of "bugology"!

GEORGE C. WHEELER
Department of Biology, University of North Dakota

[1] Presumably meaning "hybrid" or "mongrel."

National Conference of Science for Peace

AT THE first National Conference of "Science for Peace," which was held in London Jan. 19–20 and was attended by 180 scientists, two resolutions were passed unanimously. As provisional secretary of this organization I have been asked to send you the text of these resolutions in the hope that you will give them such publicity as you think fit.

I should point out that the resolution on biological warfare should not be taken to advocate unilateral abrogation of secrecy, but that recommendations (ii) and (iii) were intended by the proposer to be contingent upon (i):

This Conference notes with approval the resolution carried unanimously at the International Congress of Microbiology at Copenhagen in 1947 in the following terms:—

"The IVth International Congress of Microbiology joins the International Society of Cell Biology in condemning in the strongest possible terms all forms of biological warfare. The Congress considers such barbaric methods as absolutely unworthy of any civilised community and trusts that all microbiologists throughout the world will do everything in their power to prevent their exploitation."

This Conference agrees that scientists have a duty to make clear their opposition to this misuse of biological knowledge, since it realises that silence would generally be interpreted as meaning agreement with such developments.

It realises that, in the present state of international tension, governments may feel bound to prepare measures for defence of the population of their countries against the threat of attack by biological weapons. Research into defence against biological attack, however, necessarily requires simultaneous research into methods of using biological weapons and once such knowledge is accumulated, under conditions of secrecy, it may not be possible to prevent it being used. Further, secret work, whether aimed at methods of defence or attack, only increases international suspicion.

This conference therefore calls on H. M. Government:—

(i) to enter into negotiation with other Governments with a view to a general formal repudiation of any use of biological warfare and to working out practical measures to ensure that this repudiation is effective;

(ii) to refrain from imposing conditions of secrecy upon workers at any government-sponsored research institute engaged in work which might bear on the problems of biological warfare; and to allow inspection of such institutes by accredited representatives of a recognised international organization;

(iii) to secure the full publication of the results of all such research, including secret work already completed, whether or not it was directly concerned with biological warfare.

The present discussions between the Great Powers on disarmament and the control of atomic energy have once again quickened the hopes of people everywhere that agreement may be reached and the threat of a third world war removed. This Conference affirms the view that:

1) International agreement on the elimination of atomic weapons with strict international control and inspection is essential if the present international tension is to be eased.

2) Now that it is agreed by all the Powers that the elimination of atomic weapons must be linked with the control and reduction of conventional armaments there can be no basic political objection to such an agreement.

3) There are no insurmountable technical difficulties in the way of establishing an effective system of control and inspection, containing in itself automatic guarantees of its fulfilment and possible to operate even in a period of international tension.

4) The differences in policy on international control between the various countries are not as great as has sometimes been suggested and are capable of resolution by compromise.

5) In particular, the stress that has been laid on international ownership of large-scale atomic establishments is not justified. Although such ownership might facilitate control, it is not essential for effective control. Since it constitutes a major stumbling block we respectfully suggest to our Government that it should use its influence to secure that this proviso is not allowed to hold up a general agreement.

A. H. GORDON
Science for Peace Committee, London, England

What GENERAL ELECTRIC People Are Saying

W. R. G. BAKER

Electronics Division

RADIO AND TELEVISION—WEAPONS OF TRUTH: The web of lies and deceit woven by the Kremlin is so tangled and so tenuous that the Communists must erect an iron curtain and must struggle continually to keep the truth from the peoples they dominate. They know they dare not admit the truth about the United States, about our standard of living, about our automobiles and homes and refrigerators, and particularly about our freedoms. They fear the truths carried by the powerful transmitters of the Voice of America, many built by and several operated by General Electric.

Lies and propaganda cannot live long where truth can be heard and seen. The sensitive ear and unblinking eye of radio and television are quick to detect the false note in the voice, or the sudden look of cupidity. A more effective weapon against propaganda than political censorship, through political selection of those events which are allowed to be reported by radio and television, would be the candid reporting of the radio microphone and television camera.

Radio has long listened and reported on governmental affairs, and it has become a past master at interpreting the world's events, although on occasion with too little reporting and too much interpreting. It is time that radio and television came of age, and lent their eyes and ears freely to the cause of communication of truth. Certainly the right of privacy is invaded if we turn on microphones and cameras during an inquisitorial congressional investigation in which no rebuttal is allowed, but this invasion of privacy stems not from the use of radio or television, but from the very procedures used by government.

Let us not forget that our government is a government by the people as well as for the people, and the closer we can come to an informed, enlightened democracy, the stronger we will be against the forces of international gangsterism, or against predatory tactics by any group, clique or faction within our borders.

Radio Station WGY, 30th Anniversary

Schenectady, N. Y., February 20, 1952

G. E. HENRY

General Engineering Laboratory

ULTRASONIC CLEANING OF SMALL PARTS: Scientific interest in the varied and startling phenomena of ultrasonics inevitably leads to the question, "What are the applications?"

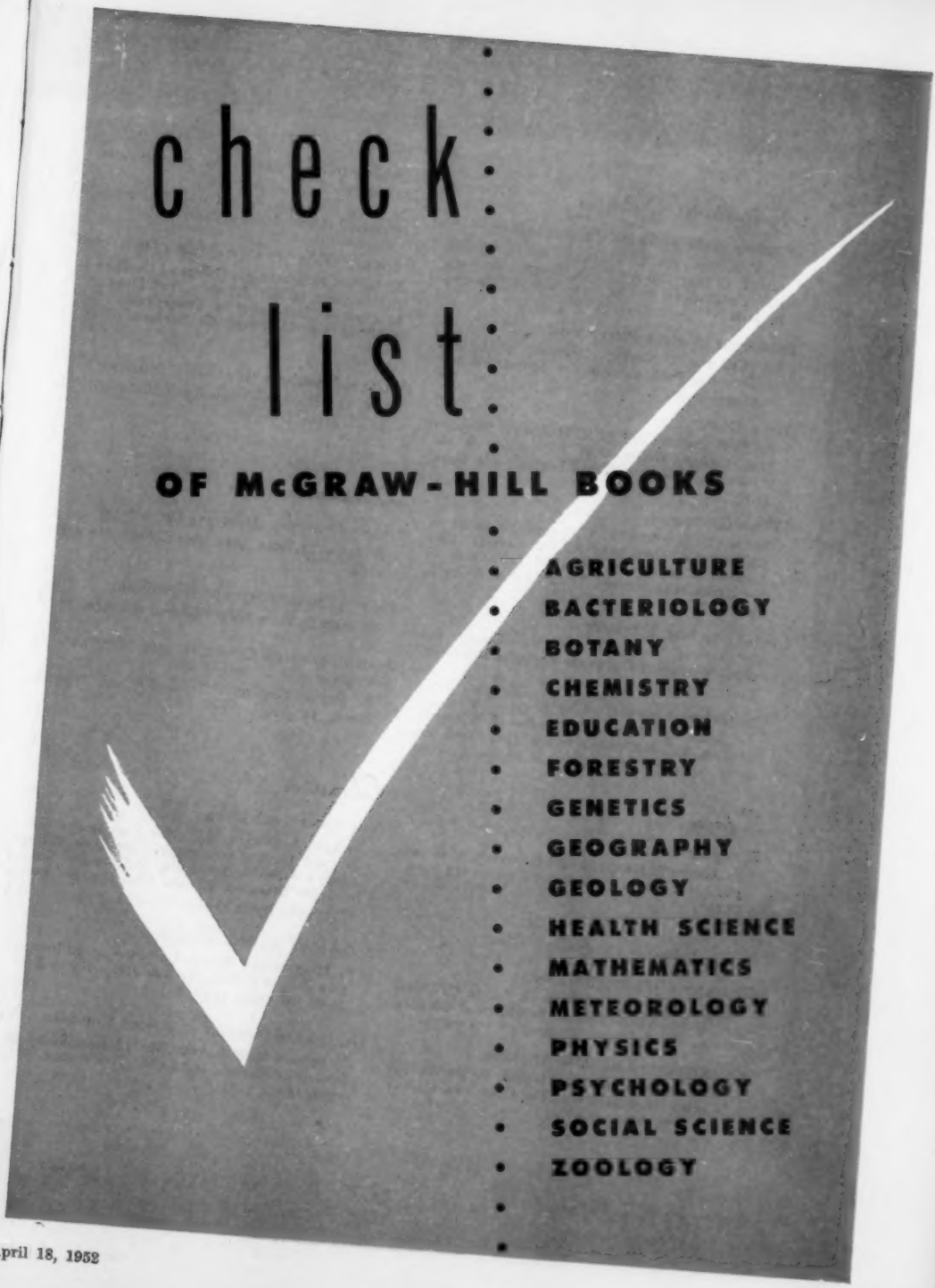
Ultrasonic cleaning is one of the best answers yet given to that question. Here is a method of removing oil, grease, chips, dirt, lapping compound, and many other contaminants from the surfaces of small precision work pieces at a rate hitherto unattainable, and to a degree of cleanliness that usually surpasses the most stringent industrial standard.

This is accomplished by beaming a high-frequency sound wave through the cleaning solvent or detergent solution, as the case may be, to the surface of the submerged work piece. The sound wave, usually, but not always, in the 300- to 1000-kilocycle-per-second range, is set up directly in the liquid cleaning bath by means of a vibrating quartz crystal. The crystal, in turn, is driven by an electronic oscillator.

Within certain limitations we can make superlative claims for this method. It is applicable to pieces of almost any material—to metals, glass, textiles, or molded products—and to pieces of practically any conceivable shape. We may even say that the more irregular the shape the better; ultrasonics is particularly good for getting at blind holes and capillary cavities. Great variety is possible in the choice of solvent, solutions, or detergents. The liquid medium must of course be compatible with the material of the work piece, and will usually be one which would accomplish a partial cleaning without ultrasonics. We confidently predict that the present decade will see many installations saving untold thousands of manufacturing dollars.

General Electric Review

March 1952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GEOLOGY
HEALTH SCIENCE
MATHEMATICS
METEOROLOGY
PHYSICS
PSYCHOLOGY
SOCIAL SCIENCE
ZOOLOGY

Publications Received

The Atom Provides a New Industrial Tool. St. Louis: Nuclear Research & Development, Inc., Industrial Division.

The Brenon Chinchilla Service Handbook. Herbert C. Brenon. Culver City, Calif.: Murray & Gee, 1952. (No price given.)

The City. Man and his World Series for Junior and High School Grades. Rod and Lisa Peattie. New York: Schuman, 1952. 108 pp. $2.50.

Communication of Technical Information. Robert M. Dederich. New York: Chemonomics, 1952. 116 pp. $5.00.

Counseling in Catholic Life and Education. Charles A. Curran. New York: Macmillan, 1952. 462 pp. $4.50.

Samuel S. Fels Fund: A Report for the Period from Its Inception to December 31, 1951. Philadelphia. 75 pp.

Flora of the Charleston Mountains, Clark County, Nevada. University of California Publications in Botany Volume 24. Ira W. Clokey. Berkeley and Los Angeles: Univ. California Press, 1951. 274 pp. $2.74 paper; $3.75 cloth.

Foundations of High Speed Aerodynamics. George F. Carrier, Ed. New York: Dover Pubs., 1951. 286 pp. $1.75.

Genetics Laboratory Manual. Eldon J. Gardner. Minneapolis: Burgess, 1952. 53 pp. $1.50.

Graphic Survey of Chemistry. William Lemkin; Vinton R. Rawson, Ed. New York: Oxford Book Co., 1952. 410 pp. $.85; cloth $1.65.

Important Tree Pests of the Northeast. Committee on Tree Pest Leaflets, New England Section, Society of American Foresters, Ed. Concord, N. H.: Evans Printing Co., 1952. 191 pp. $2.00.

Laboratory Exercises in General Biology. 4th ed. James Watt Mavor. New York: Macmillan, 1952. 333 pp. $3.50.

The Language Laboratory. The report on the second annual round table meeting on linguistics and language teaching at Georgetown University. Washington: Educational Laboratories, Inc. Free.

Manipulations de Chimie. 10th ed. Clement Duval. Paris: Masson, 1951. 382 pp.

Materiaux pour L'Etude de L'Economie Rurale des Populations de la Cuvette Forestiere du Congo Belge. A.–G. Baptist. Bruxelles: M. Hayez, 1951. 63 pp. 50 fr.

Matter and Motion. James Clerk Maxwell. New York: Dover (repr.) 163 pp. $1.25.

Medical Certification of Cause of Death. Instructions for Physicians on Use of International Form of Medical Certificate of Cause of Death. Geneva: World Health Organization, 1952. 20 pp. 20¢.

Microtechnique: A Student's Guide to Slide-Making. Arthur W. Jones and John M. Carpenter. Minneapolis: Burgess, 1952. 39 pp. $1.50.

Motor Phonetics. A study of Speech Movements in Action. R. H. Stetson. Amsterdam: North-Holland Pub. Co., 1951. 212 pp. (No price given.)

National Institute of Genetics (Japan) Annual Report. Misima, Sizuoka–Ken: National Institute of Genetics, 1951. 53 pp.

The National Research Council Review 1951. Ottawa: Edmond Cloutier, 1952. 285 pp. 75¢.

Meetings & Conferences

Apr. 22–25. Conference on Labor (Annual). Arthur T. Vanderbilt Hall, New York University Law Center, New York.

Apr. 25–26. American Mathematical Society (Eastern), Columbia University, New York; (Western), University of Chicago.

Apr. 25–26. Arkansas Academy of Science. Jonesboro.

Apr. 25–26. Midwestern Psychological Association. Cleveland.

Apr. 25–26. National Office Management Association. Chalfonte-Haddon Hall, Atlantic City.

Apr. 25–26. Western Psychological Association. Fresno, Calif.

Apr. 26. Catholic Round Table of Science, Pennsylvania Chapter (Spring). Mount Mercy College, Pittsburgh.

Apr. 26–May 4. Science Fair. Franklin Institute, Philadelphia.

Apr. 26–May 11. Foire International de Liége. Liége, Belgium.

Apr. 27–May 1. American Ceramic Society (Annual). William Penn Hotel, Pittsburgh.

Apr. 28–30. American Oil Chemists' Society (Spring). Shamrock Hotel, Houston.

Apr. 28–30. Fisheries Council (Annual). Vancouver, B. C., Canada.

Apr. 28–30. National Academy of Sciences. Washington, D. C.

Apr. 29. International Hydrographic Conference. Bureau Hydrographique Internationale. Monte Carlo.

Apr. 29–30. Metal Powder Show and Metal Powder Association (Annual). Drake Hotel, Chicago.

Apr. 30–May 2. Natural Gasoline Association of America (Annual). Rice Hotel, Houston.

May 1–2. American Venereal Disease Association and Experimental Therapeutics Study Section of National Institutes of Health, Symposium on Venereal Diseases (Annual). Washington, D. C.

May 1–3. American Goiter Association. St. Louis.

May 1–3. American Physical Society (Spring). Washington, D. C.

May 1–3. Amputee Conference (Annual). Kessler Institute for Rehabilitation, West Orange, N. J.

May 1–3. Geological Society of America, Southeastern Section and Southeastern Mineral Symposium. Hotel Roanoke, Roanoke, Va.

May 1–3. New York Geological Association (Annual Field Meeting). Buffalo.

May 1–4. American Association for the Advancement of Science, Southwestern Division. University of Colorado, Boulder.

May 1–7. American Foundrymen's Society (Annual). Atlantic City.

May 1–7. International Foundry Congress and Show. Atlantic City.

May 2–3. American Council on Education (Annual). Palmer House, Chicago.

May 2–3. Association for Computing Machinery. Mellon Institute, Pittsburgh.

May 2–3. Mississippi Academy of Science. Buena Vista Hotel, Biloxi.

May 2–3. West Virginia Academy of Science (Annual). West Virginia Wesleyan College, Buckhannon.

May 3. American Mathematical Society (Far Western). Fresno State College, Fresno, Calif.

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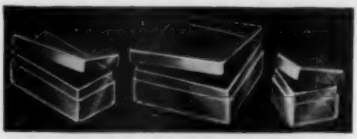

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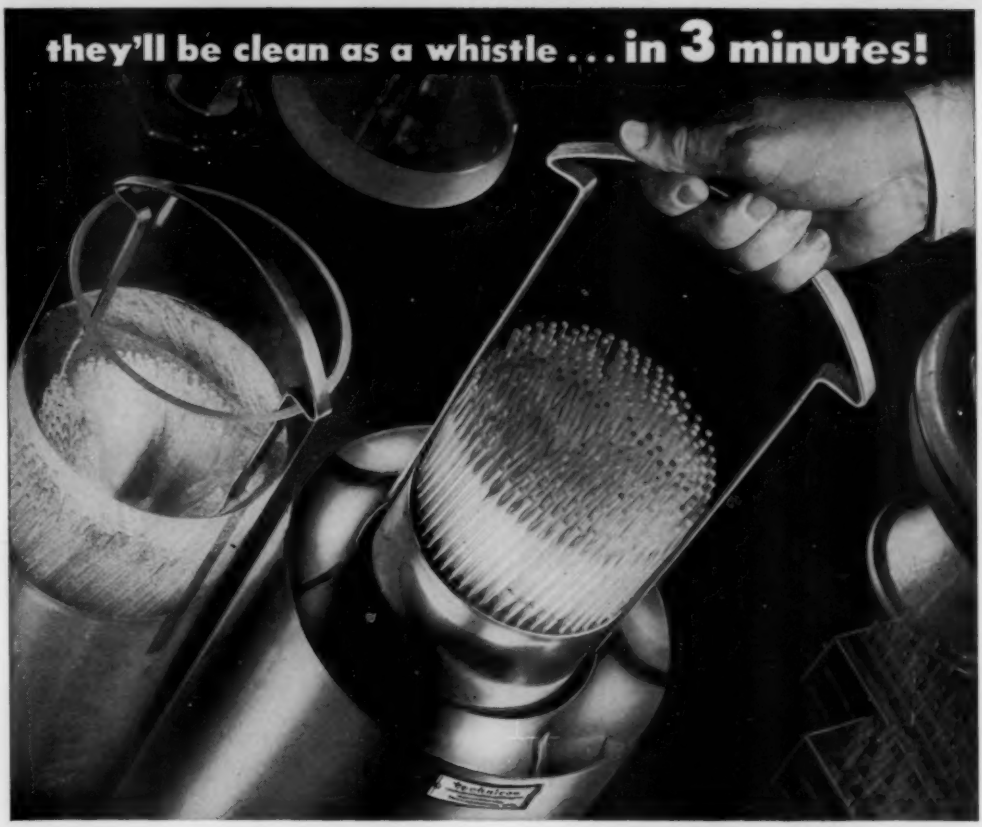

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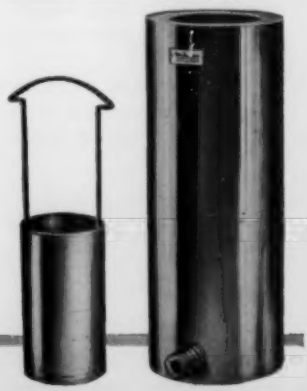

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